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Long Term Production Outlook For The Canadian Aquaculture Industry

Economic and Commercial Analysis
Report No. 13

Fisheries and Oceans | Pêches et Océans

Canada

Long Term Production Outlook For The Canadian Aquaculture Industry

Commercial and Market Analysis Division

Economic and Commercial Analysis Directorate
Department of Fisheries and Oceans
Ottawa, Ontario
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ABSTRACT

Aquaculture in Canada is a young and dynamic industry and commercial development, particularly in the past few years, has been very dramatic. Recent growth has been fuelled by favourable market opportunities and expected profitability.

As the lead department for aquaculture, the Department of Fisheries and Oceans has encouraged this industry and is developing an aquaculture strategy to further the sustained growth and development of aquaculture in Canada. In preparation for this strategy, and to provide a systematic projection of future aquaculture production in Canada, the Economic and Commercial Analysis Directorate of the Department of Fisheries and Oceans engaged Price Waterhouse Management Consultants to forecast Canadian aquaculture production to the year 2000.

Price Waterhouse developed three growth scenarios for each major species group now produced commercially in Canada: salmon, trout, oysters and mussels. Separate production and employment forecasts are provided.

The views and opinions expressed in the report are those of the consultants and do not necessarily reflect the views of the federal Department of Fisheries and Oceans.

RÉSUMÉ

Industrie jeune et dynamique, l'aquiculture canadienne a connu, surtout au cours des quelques dernières années, un développement commercial très rapide. La croissance récente a été poussée par une conjoncture commerciale favorable et des bénéfices prévisibles.

A titre de chef de file en matière de l'aquiculture, le ministère des Pêches et Océans a apppuyé cette industrie et est en train d'élaborer une stratégie afin de continuer la croissance soutenue et le développement de l'aquiculture au Canada. Dans cette optique et pour fournir une projection systématique de la production aquicole de demain, la Direction générale de l'analyse économique et commerciale du ministère des Pêches et Océans a retenu les services de Price Waterhouse Management Consultants pour prévoir cette production canadienne jusqu'à l'an 2000.

La société Price Waterhouse a élaborer trois scénarios de croissance pour chaque principal groupe d'espèces maintenant élevées commercialement au Canada: le saumon, la truite, les huîtres et les moules.

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Les vues et les opinions qui y sont formulées sont celles des consultants et ne traduisent pas nécessairement celles du ministère fédéral des Pêches et Océans.

DEPARTMENT OF FISHERIES AND OCEANS

LONG TERM PRODUCTION OUTLOOK FOR THE CANADIAN AQUACULTURE INDUSTRY

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DEPARTMENT OF FISHERIES AND OCEANS

LONG TERM PRODUCTION OUTLOOK FOR THE CANADIAN AQUACULTURE INDUSTRY

EXECUTIVE SUMMARY

The Federal Department of Fisheries and Oceans has commissioned Price Waterhouse to assess the growth potential of the Canadian aquaculture industry to the year 2000. The major species considered include farmed salmon, oysters, mussels, and trout.

Making long term projections is a challenging task, particularly when an industry is relatively young and still growing at a very high rate. For this reason, three scenarios were developed for each major specie, namely high, medium and low growth. The underlying assumptions for each scenario are spelled out in the text to enable the reader to better evaluate the projections.

In conducting this work we relied on publicly available data and information provided by numerous industry and government officials. The work was conducted over a limited time and budget and further in-depth investigations should be carried out before anyone decides to invest on the basis of these projections. Furthermore, the scenarios developed in this report represent the views of the authors based on the information available at the time of writing. These projections do not necessary reflect the views of the Department of Fisheries and Oceans or any other individuals and organizations contacted in the process of conducting the study.

The results of our analysis are summarized below and are presented in detail in the report. The enclosed report presents a detailed review of the analysis.

THE SALMON INDUSTRY IN BRITISH COLUMBIA

. The B.C. salmon farming industry has grown from about one or two commercial farms in the early 1970's to up to 125 operating farms in 1988. 1988 production is expected to be 4,500 MT, compared to 1,200 MT in 1987 and a commercial salmon catch of about 67,000 MT in 1987.

. The B.C. salmon farming industry is still at an infancy stage when compared to the salmon farming industry in Norway. In 1988, farmed salmon production for Norway is expected to be 80,000 MT, as compared to about 100 MT in 1971. Other countries which are becoming important producers of farmed salmon include Scotland, Japan and Chile.

. The B.C. industry may duplicate at least partly the high growth experienced in Norway over the last decade. The industry is likely to produce between 20,000 MT and 30,000 MT by 1995 and between 25,000 MT and 50,000 MT by the year 2000. The B.C. production is unlikely to match the existing Norwegian production of 80,000 MT by the year 2000 because of increasing competition from other countries and market constraints.

. For the production of B.C. farmed salmon to reach 50,000 MT by the year 2000:
  - the profitability in the industry will have to materialize;
  - prices will have to remain close to existing levels so as to stimulate further investment in the industry. (World supplies of salmon and particularly farmed salmon are expected to rise significantly in the next decade but demand for fresh fish also has the potential to increase.);
  - salmon farms will be required to contain production costs, specifically feed costs; and
  - new entrants will have to obtain capital during the early years of development.

. Under a low growth scenario, B.C. farmed salmon production will continue to grow for the next five to seven years up to about 20,000 MT and then plateau as increased farmed fish production is achieved world wide. The industry may be plagued by production problems resulting in financial difficulties. The industry may also face significant market constraints and declining prices.

SALMON INDUSTRY IN EASTERN CANADA

. The salmon farming industry in Eastern Canada is concentrated in the Bay of Fundy in New Brunswick, where 34 salmon farms are currently operating. Together these farms have a combined capacity of 4,800 MT and they produced about 3,000 MT of salmon in 1988.

. In Nova Scotia, there are 13 operating marine sites which reported growing salmon in 1988, ten of which also produced rainbow trout in sea cages. Production excluding marine rainbow trout was 37 MT in 1987. Data are not available for 1988 but the projections are based on an estimated production of 150 MT. Some production estimates for 1988 for that province are as high as 700 MT and the achievement of a much different production level would impact on the projections.

. Salmon farming in Quebec and P.E.I. is limited to land based facilities because of severe winter water temperatures and ice. There are two such facilities in operation, one in each province. A land based farm is also currently under construction in Nova Scotia.

. Salmon aquaculture in Newfoundland is at an experimental stage. The industry suffered a major setback in 1988 when the existing stock of farmed salmon, smolts, and market fish was destroyed because of infection.

. In Eastern Canada, New Brunswick shows the most potential for growth, followed by Nova Scotia, and the other three provinces. By 1995, the five provinces are expected to produce between 4,600 MT and 11,000 MT of farmed salmon and by the year 2000, production will likely reach between 6,000 MT and 16,000 MT of farmed salmon. Major assumptions underlined in these projections are as follows:
  - the current technology of net pens operating in sea water will continue to be the most prevalent technology used in salmon farming. Technological changes and the widespread adoption of land based and other systems could result in higher than projected growth. Land based systems are technically feasible, but their commercial viability has yet to be established;
  - the number of sites available in New Brunswick will be between 35 (existing) and 75 sites, which translates to a production capacity of about 10,000 MT;
  - by the year 2000, the industry in Nova Scotia is expected to produce between 500 and 3,000 MT depending on their ability to rear salmon competitively; and,
  - there are limited opportunities for PEI, Newfoundland and Quebec to expand the salmon farming industry, primarily because land based facilities are capital intensive and their economic feasibility is still being assessed. Moreover, attempts to grow smolts in Newfoundland may continue to be hampered by disease problems.

THE OYSTER INDUSTRY IN B.C.

. 1988 oyster production in B.C. is estimated at 3,000 MT. Studies indicate that B.C. waters can produce 10 to 50 times the current quantity of oysters but the industry is likely to produce only between 4,000 and 7,000 MT by 1995 and 5,500 MT to 13,000 MT by the year 2000.

. Major conditions which will restrict the growth of the industry include the cost and availability of seed from hatcheries and financing. Markets could also be a restricting factor, although under the low growth scenario, the projected production to the year 2000 of 5,500 MT will be about equal to the 1963 production of 5,900 MT. Oyster production declined since that time due to poor growing techniques and reliance on national oyster seed. A major disease outbreak or contamination could also be disastrous to the industry.

THE OYSTER INDUSTRY IN EASTERN CANADA

. Oyster production in the Atlantic provinces is about 2,600 MT and because of water temperatures and other conditions, is limited to New Brunswick, Nova Scotia and P.E.I.

. There is significant potential to increase oyster production in Atlantic Canada, particularly with the recent establishment of a hatchery in Nova Scotia. Atlantic oyster production is likely to reach between 3,000 MT and 5,000 MT by 1995 and between 4,000 MT and 9,000 MT by the year 2000.

. The achievement of these production levels will be largely dependent on markets and the ability of Canadian producers to remain competitive with U.S. producers. Conditions which could seriously restrict the growth of the industry include:
  - the need to develop markets;
  - the reliance on the one hatchery in Nova Scotia to produce oyster seed;
  - the ability of producers to remain competitive relative to U.S. producers; and
  - the large financing requirements, because the European and American oysters take a number of years to reach market size.

THE MUSSEL INDUSTRY

. Mussel production in Canada is expected to exceed 2,000 MT in 1988 with P.E.I. accounting for about 70% of this production. (This is based on data published by the P.E.I. government and the Department

of Fisheries and Oceans; estimates of historical mussel production for P.E.I. and Atlantic Canada vary widely depending on the source of data.) Production increased in 1988 despite a health alert on mussel cultivation after mussel related cases of poisoning were reported.

. Industry production in Atlantic Canada is likely to range between 3,500 MT and 5,000 MT by 1995 and between 4,000 and 7,000 MT by the year 2000. The potential for mussel production to continue to grow will largely depend on the industry to develop markets and maintain prices at or above the current level. Even if the number of sites in P.E.I. and the production capacity of that province prove to be limited, there are enough sites in the other Atlantic provinces to allow the industry to develop provided that markets exist.

. The situation in B.C. is quite different than in Eastern Canada. The blue mussel grows well throughout the province although commercial ventures have not proved feasible primarily because of:
  - severe diving duck predation;
  - unexplained pre-harvest mortalities; and
  - fouling by a variety of organisms including barnacles and tunicates which add to the weight of the lines and require additional floatation.

  Depending on B.C.'s ability to control these problems cost effectively, the mussel industry in B.C. will either remain at an infancy stage, and produce about 50 MT by the year 2000, or it will become a viable industry which could produce as much as 1,000 MT by the year 2000.

TROUT FARMING

. The production of farmed trout for human consumption started on a commercial basis about 25 years ago in Ontario. Trout production in Canada now exceeds 2,500 MT, two-thirds of which is from Ontario.

. Trout farming in Canada is carried out primarily in fresh water. However, with the growth of marine culture, the industry has been rearing marine trout in sea cages, primarily in Nova Scotia.

. The trout farming industry is not new to Canada but it still offers significant potential for growth. The industry is likely to produce between 2,800 MT and 5,200 MT of freshwater trout by 1995 and between 3,500 MT and 7,300 MT by the year 2000. Production of marine trout is likely to range between 1,000 MT and 4,000 MT by the year 2000.

- A key challenge facing the freshwater and marine trout industries will be to develop markets in an environment which will become increasingly competitive. The ability to maintain costs will also be a challenge to the industry. The freshwater trout farming sector yields only modest returns to the owner operators and investors. Throughout Canada, trout farming presents an alternate source of income to traditional farming and it is likely to grow over the next decade.

CONCLUSION

The aquaculture industry in Canada is here to stay. In 1988, the salmon, oyster, mussel and trout farming sectors created about 1,500 direct full-time equivalent positions, excluding employment in hatcheries and industries supplying the industry.

The industry is young and dynamic and the potential for growth is substantial. By the year 1995, the cultivation of salmon, oysters, mussels and trout is likely to create between 1,800 and 3,200 full-time positions. By the year 2000, this number is expected to range between 2,100 and 5,000. The number of people involved in the industry, however, will likely be one to two times larger as the industry involves seasonal employment and the culture of some of the species like mussels and trout is often done in combination with farming and other activities.

A summary of the employment and production projections are presented in Tables 1 and 2 following.

** ** ** **

We would like to thank the Department of Fisheries and Oceans and the many individuals who participated in this study for their time and co-operation.

Price Waterhouse
management consultants,
Vancouver, B.C.
January, 1989

TABLE 1

SUMMARY OF OUTLOOK

PRODUCTION PROJECTIONS

(metric tonnes)

	Salmon			Oysters		
	1988	1995	2000	1988	1995	2000
B.C.	4,500	20,000-30,000	25,000-50,000	3,100	4,000- 7,000	5,500-13,000
Eastern Canada(1)	3,250	4,600-11,000	6,000-16,000	2,600	3,000- 5,000	4,000- 9,000
Total	7,750	24,600-41,000	31,000-66,000	5,700	7,000-12,000	9,500-22,000

	Mussels			Marine Trout(1)		
	1988	1995	2000	1988	1995	2000
B.C.	-	10- 100	50-1,000	100	250-1,000	500-2,000
Eastern Canada	2,000	3,500-5,000	4,000-7,000	250	250-1,000	500-2,000
Total	2,000	3,510-5,100	4,050-8,000	350	500-2,000	1,000-4,000

	Freshwater Trout		
	1988	1995	2000
B.C.	125	100- 300	200- 600
Atlantic Canada	125	100- 200	200- 300
Ontario	1,814	2,000-3,500	2,400-4,500
Quebec	250	500-1,000	600-1,500
Prairies and Territories	100	100- 200	100- 400
Total	2,414	2,800-5,200	3,500-7,300

Note:

1. Salmon production in 1988 includes 3,000 MT in New Brunswick and 250 MT from Nova Scotia and the other provinces.

TABLE 2

SUMMARY OF OUTLOOK

EMPLOYMENT PROJECTIONS

	Salmon			Oysters		
	1988	1995	2000	1988	1995	2000
B.C.	750	950-1,500	1,050-2,400	100	130-230	180-430
Eastern Canada	170	205- 500	215- 625	85	100-165	130-300
Total	920	1,155-2,000	1,265-3,025	185	230-395	310-730

	Mussels			Marine Trout		
	1988	1995	2000	1988	1995	2000
B.C.	-	5- 10	10- 70	5	10-35	20- 75
Eastern Canada	135	230-330	250-450	10	10-35	20- 75
Total	135	235-340	260-520	15	20-70	40-150

	Fresh Trout			Total		
	1988	1995	2000	1988	1995	2000
B.C.	10	10- 25	15- 50	865	1,105-1,800	1,275-3,025
Atlantic Canada	10	10- 15	15- 25	410	555-1,045	830-1,475
Ontario	150	165-290	200-375	150	165- 290	200- 375
Quebec	20	40- 80	50-125	20	40- 80	50- 125
Prairies & Territories	10	10- 15	10- 30	10	10- 15	10- 30
Total	200	235-425	290-605	1,455	1,875-3,230	2,165-5,030

Note:

Data represent employment in terms of full-time equivalent jobs.

INTRODUCTION

In November 1988, the Federal Department of Fisheries and Oceans commissioned Price Waterhouse to assess the outlook for the Canadian aquaculture industry to the year 2000. The major species considered include salmon, oysters, mussels, and trout.

Making long term projections is a challenging task, particularly when an industry is relatively young and still growing at a very high growth rate. For this reason, three scenarios were developed for each major specie, namely, high, medium and low growth. The underlying assumptions for each scenario are spelled out in the text to allow the reader to form his or her own opinion on the projections.

In conducting this work we relied on publicly available data as well as information provided by various industry and government officials. The work was conducted over a limited time and budget and further in-depth investigations should be carried out before anyone decides to invest on the basis of these projections. Furthermore, the scenarios developed in this report represent the views of the authors based on the information available at the time of writing. These projections do not necessarily reflect the views of the Department of Fisheries and Oceans or any other individuals and organizations contacted in the process of conducting the study.

The results of our analysis are summarized in the enclosed report in six chapters, as outlined below:

- The Salmon Farming Industry in B.C.
- The Salmon Farming Industry in Eastern Canada
- The Oyster Industry in B.C.
- The Oyster Industry in Eastern Canada
- The Mussel Farming Industry
- The Trout Farming Industry

Each chapter reviews the historical development of the industry, describes the constraints and the strengths of Canadian aquacultural producers and presents an outlook to the year 2000 for each of the major species.

CHAPTER 1 - THE SALMON FARMING INDUSTRY IN B.C.

HISTORICAL DEVELOPMENT OF SALMON FARMING IN B.C.

The first commercial salmon farm license was issued in British Columbia in 1972. However, throughout the 1970's and early 1980's, there were only a handful of farms operating in B.C. During that time, the industry suffered a number of setbacks including:

- low survival rates;
- lower than expected growth rates;
- lower than expected returns, particularly as farms focussed on the pansize market which proved to be less profitable than the larger size fish market; and
- under capitalization and difficulty in obtaining financing, a fact which partly resulted in the collapse of B.C.'s largest aquaculture firm, Apex Bio Resources Limited, in January 1982.

Beginning in 1984, the industry witnessed a surge in the number of operating farms and applications for operating licenses. The number of operating sites in B.C. for the years 1981 through 1988 is presented in table 3.

TABLE 3

B.C. SALMON FARMING INDUSTRY

	Number of Operating Sites(1)	Production	
		Volume (metric tonnes)	Value ($000's)
1979	N/A	41	157
1980	N/A	157	898
1981	4	176	985
1982	5	273	1,136
1983(2)	8	128	708
1984	10	107	702
1985	37	120	820
1986	69	397	2,900
1987	118	1,200	6,500
1988	125*	4,500*	N/A

* - estimated
N/A - not available

Notes:

1. Licensed operations with fish in the water.

2. The largest producer ceased production in 1982, resulting in a production decline in 1983.

Source: B.C. Ministry of Agriculture and Fisheries
B.C. Salmon Farmers Association

As shown by table 3, there were an estimated 125 operating salmon farms in 1988, up from only 10 in 1984. There are currently 178 approved salmon farm tenures but a number of these are not yet operating. There are also between 100 and 200 development and expansion plans being reviewed by the B.C. Ministry of Agriculture and Fisheries.

Table 3 also shows farmed salmon production in B.C. over the last decade. Farmed salmon production in B.C. remained between 100 and 300 MT per year throughout the 1980's. It then started to increase significantly in 1987

when it reached 1,200 MT. In 1988, the production of B.C. salmon farms is expected to be 4,500 MT.

The existing farm holding capacity is estimated at four times the estimated production for 1988, or about 21,000 MT. This is based on 125 operating farms and an average farm capacity of 170 MT as determined in the 1987 survey of operating farms which is conducted each year by the B.C. Ministry of Agriculture and Fisheries. Fish production is still low relative to capacity because of the lead time required for salmon to reach marketable size. Also, existing farms do not normally stock at capacity during start-up since cash flow is often a problem.

In 1988, the industry in B.C. had an estimated 875 employees, including 375 full-time farm workers, 250 part time, and 250 office staff. These data are based on the above mentioned 1987 survey which determined that the average operating farm in B.C. employed 3 full-time, 2 part-time and 2 administrative employees.

The B.C. industry has been growing but it is still only a fraction of the commercial fishing industry. Table 4 shows the volume and value of the commercial catch in B.C. for 1986 and 1987. As shown by that table, in 1987, the commercial salmon catch in B.C. was about 67,000 MT valued at about $225 million, down from 100,000 MT and $266 million in 1986. The commercial catch for salmon varies widely from year to year with the 1986 catch being a record high.

TABLE 4

B.C. LANDINGS OF WILD SALMON

	1986		1987	
	Weight(1) (tonnes)	Value (millions)	Weight(1) (tonnes)	Value (millions)
Pink	29,264	$ 26	26,942	$ 32
Sockeye	29,811	143	15,041	92
Chum	24,922	38	11,076	24
Coho	11,666	39	8,436	41
Chinook	4,420	20	5,263	36
	100,083	$266	66,758	$225

Source:

1986: B.C. Ministry of Agriculture and Fisheries, Fisheries Production Statistics of British Columbia, 1986.

1987: Preliminary 1987 data, Department of Fisheries and Oceans and Price Waterhouse Survey. As reported in Economics Impacts of Fishing in British Columbia - 1987, Fisheries Council of British Columbia, prepared by Price Waterhouse, September 1988.

The salmon farming industry in B.C. is characterized by farms which raise salmon to market size in net pens in salt water. With this system, nets are sewn in a bag-like configuration and suspended from floating support structures.

There are two other methods of salmon farming namely sea ranching and land-based or sea-based closed farming systems.

In sea ranching, smolts are produced in hatcheries, released in a creek near the ocean, and harvested when they return to their place of release just before spawning. The percentage of fish which return to their place of release is relatively low, with industry estimates ranging between 1 and 10%. This percentage increases when fish are restricted to selected bays or inlets by electric fences, but the feasibility of this method has not been determined. Sea ranching is not permitted in B.C.

With land-based and sea-based closed farming systems, fish are grown in tanks or bag-like structures which are installed on land or at sea. Water is circulated using pumps and generators and these systems are expected to yield lower mortality rates and to create a disease-free, controlled environment. There is a small number of farms in B.C. and elsewhere which are experimenting with land-based or sea-based closed systems. However, the capital investment is large relative to the traditional net pen system and the long term feasibility of closed systems is still being assessed.

HISTORICAL DEVELOPMENTS IN OTHER COUNTRIES

The B.C. salmon farming industry is still at an infancy stage when compared to the salmon farming industry in Norway. In a span of about 15 years, farmed salmon production in Norway increased from about 100 tonnes in 1971 to nearly 50,000 MT in 1987. In 1988, Norway's production of farmed salmon is expected to be 80,000 MT or about the same level of production as the entire catch of B.C. wild salmon.

Farmed salmon production for Norway since 1971 is presented in table 5 following.

TABLE 5

NORWAY SALMON FARMING PRODUCTION
(metric tonnes)

1971	98
1972	146
1973	171
1974	601
1975	862
1976	1,431
1977	2,137
1978	3,540
1979	4,389
1980	4,312
1981	8,910
1982	10,266
1983	17,016
1984	22,300
1985	28,655
1986	45,675
1987(1)	47,000*
1988	80,000*

* - estimated

Note:

1. In 1987, a plankton bloom was responsible for a loss in production in Norway, a fact which explains the lower growth in production in that year.

Source:

1971 - 1984: Aquaculture in Norway, Professor D. Harold Skjervold, Interaqua, Paper presented to Fish Farming Infrastructure Seminar, in Vancouver, June 1987, Norway Trade Commissioner.

1985 - 1988: Norway - Fish Farming Abroad, A Special Edition of 'Norskfiskeoppdrett' September 88, page 42.

Norway exports the majority of its farmed salmon production to France, Denmark and other European countries as well as to the United States and

Japan. Markets for Norwegian farmed salmon production are summarized below for 1988.

TABLE 6

1988 MARKETS FOR NORWEGIAN FARMED SALMON PRODUCTION
(metric tonnes)

France	17,000
Denmark (1)	12,000
U.S.A	12,500
Germany	7,000
Sweden	3,000
Spain	2,900
Japan	2,300
U.K.	2,500
Belgium	2,200
Domestic and other	18,600
Total production	80,000

Note:

1. The majority of the farmed salmon exported to Denmark is smoked and re-exported to the EEC.

Source: Norwegian Farming Abroad, A Special edition of Norskfiskeoppdrett, September 1988.

The existing capacity of salmon farms in Norway is estimated to be about 100,000 MT and production is expected to reach that level in 1989. There are currently about 750 salmon farms in Norway employing about 4,000 individuals, an average of 5 employees per farm. Each farm has a holding capacity of about 133 MT but the size of farms in Norway is regulated by governments to 8,000 M^3 in volume. Norway is in the process of expanding the limit to 12,000 M^3. This will potentially increase farm capacity to about 200 MT in sustainable annual production using an 88% mortality rate and a stocking density of 20 kg/M^3.

At the present time, Norway produces the majority of the world farmed salmon production. However, commercial production has begun in many other

countries including Scotland, Japan, Iceland, the United States and Chile. Table 7 shows 1987 worldwide production of farmed salmon for selected countries as well as estimates for 1988. Historical production by country between 1981 and 1988 is presented in appendix 1.

TABLE 7

WORLDWIDE PRODUCTION OF FARMED SALMON FOR SELECTED COUNTRIES
(metric tonnes)

	1987	1988 Estimate
Norway	47,000	80,000
Scotland	13,000	21,000
Japan	12,000	15,000
Western U.S.	2,025	2,500
Chile	1,700	3,000
Ireland	2,000	5,000
Faroe Island	2,500	3,600
British Columbia	1,200	4,500
New Zealand	1,200	1,600
Eastern Canada	600	2,800
Iceland	800	1,400
Other	600	600
	84,625	141,000

Source:

1988 production estimates are based on forecasts published in:

- Norway Fish Farming Abroad - A Special Edition of NORSKFISKEOPPDRETT, September 1988.
- Worldwide Farmed Salmon Production Forecasts to the Year 2000. Study prepared for the Department of Fisheries and Oceans by the DPA Group Inc., March 1988.

1987 Data: Worldwide Markets for Salmon, Pen Reared Impacts, prepared for the State of Alaska, April 1988.

As shown on table 7, Scotland is the second largest producer of farmed salmon after Norway. Production in that country is expected to reach 21,000 MT in 1988 up from a production of 13,000 MT in 1987 and only about 1,000 MT in 1981. Production in Scotland has grown at about the same rate as in Norway once a 1,000 MT production level had been achieved.

In 1987, there were 207 operating farms in Scotland which together employed 608 full-time and 198 part-time staff or an average of 4 employees per farm. The total employment impact of the industry, however, is closer to 1,500 because of some 350 employees working in the smolt production industry and an estimated 350 in other companies supplying the industry.

Japan is the third largest producing country after Norway and Scotland. Production in that country is estimated at 12,000 MT in 1987 and 15,000 MT in 1988. The industry in Japan has grown at about the same rate as in Norway once a production level of 1,000 MT had been reached. Japan produced about 1,000 MT in 1981 and about 7,000 MT five years later compared to Norway which reached about 1,500 MT in 1976 and 8,900 MT five years later.

In summary, the salmon farming industry has been gaining momentum not only in British Columbia but throughout the world. The next two sections review the constraints and opportunities facing the B.C. industry.

CONSTRAINTS FACING THE B.C. INDUSTRY

The major constraints facing the B.C. industry are as follows:

- Production;
- Financing;
- Research and development;
- Attitudes of other groups; and
- Marketing.

Production

Production levels of farmed salmon in B.C. have been affected by diseases, high mortality rates and difficulties associated with raising Pacific salmon species.

There are a number of diseases which can limit production and affect mortality rates significantly:

- A few species of plankton are harmful to fish, and when they occur in large numbers ('blooms'), they can cause mortalities of fish and other organisms. In 1987, a plankton bloom was responsible for a loss in production in Norway of about 5,000 MT, representing about 10% of production. Plankton blooms have also been experienced in certain regions of B.C.

- Certain bacteria affect internal organs of the fish and can cause death or reduce weight gain, as is the case with Bacterial Kidney Disease (BKD), one of the most problematic diseases facing the industry at this time. There are a number of vaccines and production techniques which prevent the occurrence of diseases. However, the industry is continuing to develop new vaccines and production methods and researching the various diseases.

Plankton blooms and other diseases affect wild fish as well as farmed fish although the concentration of farmed fish in one area increases the likelihood of heavy losses.

B.C. has also experienced some difficulties with raising Pacific salmon species:

- Norway and EEC countries grow only Atlantic salmon and initially, B.C. attempted to grow Pacific salmon using the same guidelines as those used for Atlantic salmon. In fact, Pacific salmon proved to require densities of 4 to 8 kilograms per cubic metre compared to between 15 and 20 kg per M^3 with Atlantic salmon.

- The B.C. industry experienced difficulties in rearing coho stocks to marketable sizes within a consistent time frame as experiments undertaken to grow neutered coho (fish genetically engineered to have no male characteristics) were largely unsuccessful. Now that chinook stocks are available, the industry is primarily growing chinook.

- The industry is now experimenting with growing Atlantic salmon. The first eggs supplied from domestic Atlantic stocks are being generated this year. There is some concern regarding the potential for Atlantic farmed salmon inter-breeding with the Pacific wild stock. Non-native fish raised in B.C. is therefore subject to special licensing requirements and rigid health controls. Non-native fish must also have a self-contained water supply.

Financing

Salmon farms require a significant capital investment not only for the pens and the installations but also to provide for initial operating expenses. The banking community has been reluctant to provide financing to the industry until at least one complete crop cycle has been completed. The government programs which provide financial assistance to the industry contribute only to capital expenditures except for the B.C. Aquaculture Incentive Program which covers up to $100,000 in operating expenses.

Research and Development

Salmon farming in B.C. is still at the development stage. There are still many unknowns regarding diseases, feed conversion factors and other production related matters. As described earlier, the industry is also experimenting with new technologies including land-based and ocean-based closed farming systems.

Attitudes of Other Groups

The B.C. United Fishermen and Allied Workers' Union (UFAWU) as well as other groups have voiced their concerns about the environmental impacts of fish farms. The potential for diseases to spread to the wild stock is a major concern. There is also fear that in-breeding between farmed and wild salmon could potentially reduce the strength of the wild fish stock. Regulations are in place to limit the likelihood of such negative impacts on the wild fisheries. Examples of these regulations include restrictions on the distance between farms and controls on raising Atlantic stocks.

The B.C. salmon farming industry is also attracting some negative publicity from local residents and recreational users of the shoreline.

The B.C. salmon aquaculture industry is located primarily on the south coast of the province and on Vancouver Island. Accordingly, some of the farms are located in populated regions.

Marketing

Markets have not been a constraint to growth up to this stage. However, with salmon production increasing in Norway, Chile and other countries, salmon prices may face downward pressures over the next decade. On the other hand, the high product quality and consistency of supply of the farmed salmon will put upward pressures on prices for farmed salmon. Farmed salmon also has the potential to be produced virtually year round, giving consumers a consistent supply of fresh products.

STRENGTHS OF THE INDUSTRY

As previously mentioned, there are many countries like Chile, Scotland, and the U.K. with significant investments in salmon farming. The comparative advantage of British Columbia is examined in a number of areas including:

- Proximity to markets;
- Production costs;
- Availability of sites;
- Expertise and infrastructure; and
- Government regulations.

Proximity to Markets

B.C. is close to the United States, one of the largest potential markets for farmed salmon. One of the key cost of production is delivery costs. Farmed salmon is typically sold fresh and accordingly, it needs to be delivered to markets within two days. As described earlier, exports of farmed salmon from Norway to the United States are estimated to be about 12,500 MT. When delivering to the U.S., Norway producers incur air

freight delivery costs of about C$ 2.80 per kg or about 35% of total delivered costs. Freight costs from B.C. are a fraction of this amount.

Japan is also one of the largest potential markets for farmed salmon, and B.C. can supply that market at a lower cost than Norway. Japan is becoming a major producer of farmed salmon but current and potential production is limited by detrimental warm water temperatures in the summer and the lack of available sites.

Production Costs

The cost of production of farmed salmon depends on a number of factors including the mortality rate, farm capacity, cost of feed, cost of labour, and cost of capital.

The major operating cost components of farmed salmon production are labour and feed costs. The following table summarizes data for selected cost components for Norway, Scotland and B.C.

TABLE 8

COMPARATIVE COST COMPONENTS FOR NORWAY, SCOTLAND AND CANADA

	Norway	Scotland	Canada
Feed (C$ per kg of feed)	$1.33	$1.14	$1.11
Wages and salaries			
. Farm staff - per annum	$25,000	$13,000	$20,000
. Packers - per hour	$11/hr	$4/hr	$6/hr
Interest	15%	10%	10%

Note:

Based on October 1988 exchange rates.

Source: Norwegian Farming Abroad, A Special edition of Norskfiskeoppdrett, September 1988, page 43.

As shown in this table, Norway has the highest feed costs at C$ 1.33 per kg of feed compared with C$ 1.14/kg in Scotland and C$ 1.11/kg in Canada. Although not indicated in this table, the cost of feed in Chile is very competitive. Chile is a major exporter of fish meal, one of the major raw materials for dry feeds.

Table 8 also shows that B.C. has wages and salaries which are lower than in Norway but are higher than in Scotland. Although not shown in this table, labour costs in Chile are lower than in B.C. Wages and salaries in B.C. may increase particularly if the industry becomes unionized.

The exchange rate is a very important factor in comparing the costs of production between the various countries. Chart A following and Appendix 2 present the exchange rates between the Canadian dollar and the Norwegian krona, the Chilean peso, and the British pound since 1975.

As shown by Chart A, exchange rates fluctuate widely from year to year. Relative to the Canadian dollar, the Norwegian Krona increased 21% between 1975 and 1980, decreased by 33% between 1980 and 1985 and increased again by 23% between 1985 and 1987. The British pound has followed essentially the same trends as the Norwegian currency over that period. The Chilean peso has been declining dramatically over the period relative to the Canadian dollar. However this decline has largely been matched by rampant domestic inflation, which has resulted in increased domestic input costs.

Wide variations in the exchange rates significantly alter the relative competitive position of salmon producers worldwide. Under the present rate structure, the B.C. farmed salmon cost of production is about the same as in Norway but it is higher than in Scotland and Chile.

Availability of Sites

British Columbia has thousands of kilometres of coast line and sheltered inlets and an almost unlimited supply of sites which are biologically suitable for fish farming. Selecting a site, however, depends on a number of factors including:

- Proximity to markets;
- Availability and delivered costs of feed and other supplies and services;
- Proximity to sources of pollution; and
- Level of flushing action so as to maintain dissolved oxygen concentrations in the water.

The industry worldwide generally agrees that in terms of sites and water quality, the environment in B.C. is at least as good as in Norway. Norway's coastal waters are relatively shallow in comparison to B.C. and the tidal flux on the open waters of the North Sea are significantly less than tides in the Pacific Northwest. This contributes to the pollution problems experienced in Norway as water exchange with the open sea is more restricted in Norway's fjords than in B.C.

At the present time, the majority of the operating sites in B.C. are around Vancouver Island and on the Sunshine Coast. In 1987, the latest year for which data are available, only 4 out of the 118 operating farms that year were in the Prince Rupert Region, 47 were on the Sunshine Coast/Lower Mainland Region, and the balance or 67 were on Vancouver Island and North of the Sunshine Coast. Nevertheless, there are still numerous available sites suitable for farmed salmon production, particularly on the northwest coast of Vancouver Island.

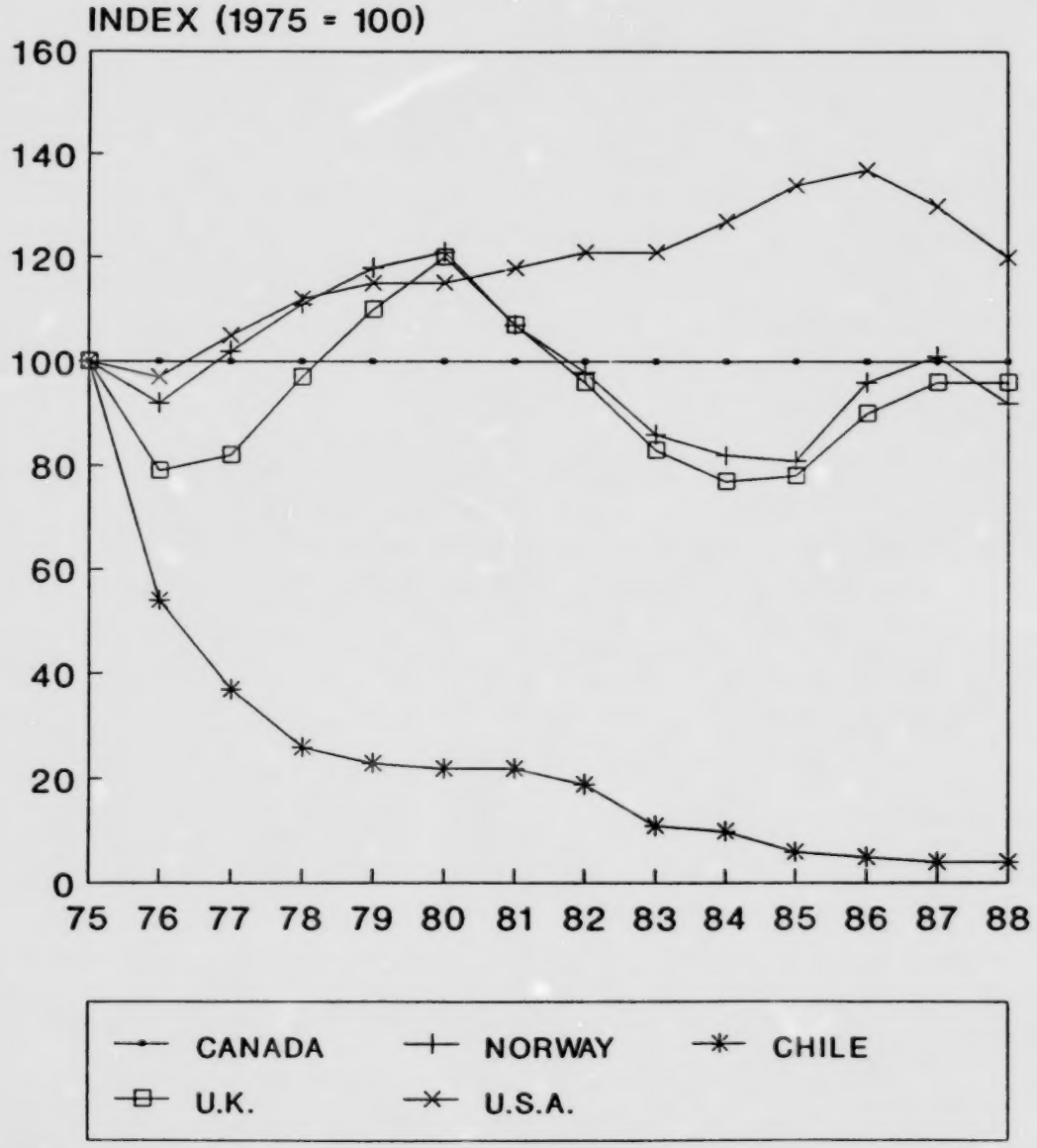
Expertise and Infrastructure

British Columbia has a well trained workforce, a large pool of research scientists as well as a well developed network of hatcheries and other organizations supplying the industry:

- B.C. has widespread technical and industry knowledge in hatchery and related fields. In developing wild salmon stocks, the Salmonid Enhancement Program (SEP) also assisted in creating an understanding of the hatching process for salmon. This expertise is directly transferable to the salmon farming industry and this has facilitated the development of private hatcheries.

Chart A

EXCHANGE RATES
1975 - 1988



Price Waterhouse

- In November 1988, there were 37 hatcheries in B.C., about half of which were combined with grow out sites. The industry in British Columbia is now expected to be self sufficient in terms of egg production. In 1988, the industry generated in excess of 50 million eggs from domestic Chinook stocks as well as the first production of eggs from Atlantic stocks.

- Because of the importance of the wild salmon fishery, local universities as well as governments have well developed research facilities and programs in oceanography and other related fields. Several technical and college programs now offer aquaculture programs leading to certification.

- A number of large companies which have processed and marketed wild salmon in the past are now entering joint venture agreements with aquaculture farms to market and distribute their products.

Government Regulations

Government regulations affecting salmon farming in B.C. are comparable to those in place in Norway and Scotland. The industry is subject to regulations pertaining to the environment, pollution, sea traffic and recreational uses in all of these countries. As was mentioned earlier, however, there are a number of regional development policies which have restricted the size and ownership of Norwegian salmon farms. Partly because of these regulations, Norwegian companies have been investing heavily in B.C. and elsewhere.

Although regulations in B.C. compare favorably with those in Norway and Western Europe, they are more stringent than in Chile. In that country, environmental issues are less of a concern, particularly since Chile has no wild salmon fishery.

OUTLOOK TO THE YEAR 2000

The purpose of this section is to project the size of the salmon farming industry to the year 2000. Because of the dynamic nature of the salmon farming industry, not only in British Columbia but worldwide, three different scenarios are developed, namely high, moderate and low industry

growth. These projections are summarized in table 9 and are described in the following sections.

TABLE 9

OUTLOOK TO THE YEAR 2000

B.C. FARMING SALMON INDUSTRY

	Production		Number of Sites		Employment by Fish Farms (1)	
	1995	2000	1995	2000	1995	2000
	(metric tonnes)					
High growth	30,000	50,000	250	400	1,500	2,400
Medium growth	25,000	35,000	200	300	1,200	1,800
Low growth	20,000	25,000	160	175	950	1,050

Note:

1. Employment estimates are based on an average of six full-time equivalent employees at each site and they exclude employment at hatcheries and other organizations supplying the farms.

High Growth Scenario

Under a high growth scenario, the B.C. industry may follow the growth experienced in Norway over the last decade. As previously mentioned, in just 16 years the industry in Norway grew from producing about 100 MT in 1971 to producing about 50,000 MT in 1987. In 1988, the Norway salmon production is expected to reach 80,000 MT. There are currently about 750 operating farms and the existing capacity is estimated at about 100,000 MT of farmed salmon.

Outlook to 1995:

Conditions in B.C. are different than in Norway, however, and the growth to the year 1995 in production is not expected to follow the same pattern. However, a high growth scenario based on the growth experienced in Norway

suggests that B.C. could produce as much as 30,000 MT by 1995. The precise annual production schedule is difficult to predict because of such factors as disease, mortality rates and overall yields.

B.C.'s 1987 production level was around 1,000 MT, about the same as Norway's production in 1976. After 1976, it took nine years for Norway to reach about 30,000 MT and another two to reach 50,000 MT. B.C. will likely reach the 30,000 MT level by 1995 or one year less than it took Norway to progress to this point from the 1,000 MT level. This is primarily because farmed salmon holding capacity in B.C. is already at about 21,000 MT, although production is still only a fraction of this capacity.

This rate of growth is consistent with that experienced in Scotland. Scotland is expected to reach the 20,000 MT level in 1988 or about seven years after production reached 1,000 MT. Japan is growing at a slower rate but conditions there are not comparable to those in B.C. Japanese production is constrained by the lack of available sites and the fact that the fish must be harvested by August before the warm water kills them.

The number of sites required to achieve a 30,000 MT production level by the year 1995 is estimated at 250. This figure is based on an average site capacity of 170 MT, the current average capacity for farms in B.C.

This capacity level is higher than the current average capacity of farms in Norway (133 MT based on 100,000 MT capacity and 750 sites). However, Norway regulates the size, location and ownership of salmon farms in that country such that the average farm size is not comparable to B.C.

The estimate of 250 sites also assumes that about half of the farms or 125 will be producing at 100% capacity while the other half will be entering the industry and producing about half of their sustainable annual average production level of 170 MT. On that basis, the 30,000 MT production level achieved in 1995 will equal about 70% of the overall holding capacity of some 42,000 MT (170 MT per site and 250 sites).

The number of sites could be lower than the estimated 250 if capacity per site increases as existing farms invest in new capacity. However, experience in Scotland shows that companies tend to increase production by increasing the number of sites rather than capacity at each site. This allows companies to diversify the risks related to diseases at any one site. In Scotland, the average site ranges between 150 MT and 250 MT.

Projected direct employment by the 250 B.C. fish farms will likely reach about 1,500 by 1995. This is based on an estimated 6 full-time equivalent positions per site, or about the current level of employment per operating site in B.C. Farms in Norway each hire an average of five employees, but the average holding capacity is smaller than the 170 MT per farm used in the B.C. projections.

The 1,500 projected employment level translates to about 28 MT of production capacity per direct job. This level is comparable to that of Norway. Employment in Norway is currently estimated at 4,000 direct farm related jobs for a production level of 80,000 MT in 1988 and a capacity level of 100,000 MT. This translates to between 20 and 25 MT per direct job.

In addition to direct employment in fish farms, the industry will create indirect employment in aquaculture service industries such as feed supplies, hatcheries and equipment dealers. It is estimated that in Norway, there are 4,000 indirect jobs bringing the total direct and indirect employment impact to 8,000. The Norwegian aquaculture suppliers, however, export equipment and other goods all over the world including B.C., and they will continue to benefit from their leadership position for some time. As a result, the employment multiplier in B.C. will likely be lower than in Norway.

Outlook to 2000:

Provided that B.C. reaches some 30,000 MT in production by the year 1995, it is conceivable that production in B.C. will continue to grow to the year 2000 at the same rate as that experienced in Norway. Under these

conditions, B.C. could reach a production level ranging between 80,000 MT to 100,000 MT by the year 2000. As previously mentioned, farmed salmon production in Norway is expected to be 80,000 MT in 1988 compared to 22,300 MT in 1984. Although the achievement of such a high production level is conceivable, there are a number of factors such as site availability, market constraints and increased competition from other countries which are likely to prevent the B.C. industry from reaching that level. Under these conditions, a projected production of 50,000 MT by the year 2000 is a realistic high growth scenario.

The number of sites required to achieve this 50,000 MT production level by the year 2000 is estimated at 400. This is based on a holding capacity of 170 MT, the existing average capacity of farms in B.C. and an average production level equal to about 70% of the overall holding capacity.

Direct employment by the 400 farms is estimated to be around 2,400 direct employees based on an average of 6 employees per farm. This excludes indirect employment in hatcheries and other related industries.

Underlying Assumptions:

In order for the industry to reach a production of 30,000 MT by 1995 and 50,000 MT by the year 2000, there are a number of factors which will have to be overcome. These include:

- Profitability in the industry will have to materialize. There are currently only a few farms recording positive cash flows. However, before the industry sees another surge in the number of sites and farms, existing operations will have to demonstrate greater levels of profitability.

- Market prices will have to remain near existing levels so as to stimulate further investment in the industry. World supplies of salmon and particularly farmed salmon are expected to rise significantly in the next decade. Projected world salmon production to the year 2000 is reported in table 10 following. While world salmon supplies are expected to increase by about 50% between 1987 and 2000, the demand for fresh fish also has the potential to increase, such that prices could potentially remain at current levels. This is particularly so because farmed salmon allows year round supply of fresh fish of a high quality.

TABLE 10

TOTAL PROJECTED SUPPLIES OF SALMON BY COUNTRY IN 2000
(000's of tonnes)

	Wild		Farmed		Total	
	1987	2000	1987	2000	1987	2000
U.S.A.	264	355	2	6	266	361
Japan	240	226	12	15	252	242
Norway	-	-	47	200	47	200
U.S.S.R.	110	107	-	-	110	107
Canada	66	93	2	39	68	132
Other	-	-	22	98	22	98
Total	680	782	85	358	765	1,140

Source:

. Projections to the year 2000 are from Perspectives on Worldwide Salmon Supplies to the Year 2000, Peter Leitz of the Department of Fisheries and Oceans and David Egan of the DPA Group Inc., proceedings to the 1988 Aquaculture International Conference.

. 1987 wild catch productions are from "World Markets for Salmon" Pen Reared Salmon Impacts, Executive Summary, prepared for the State of Alaska, April 1988.

As shown on table 10, world supplies for salmon are expected to increase by almost 50% between 1987 and the year 2000. The production of wild salmon is expected to remain stable but production of farmed salmon is expected to quadruple. Since most farmed salmon is currently sold fresh or smoked at premium prices, the price of these salmon products can be expected to drop unless the demand increases significantly.

In the short-term, salmon prices have been sensitive to supply changes. For example, between 1986 and 1987, salmon prices increased by about 20% reflecting the much smaller 1987 catch relative to 1986 in both Alaska, the Western States and B.C. In the longer-term, demand may increase such that increased supplies will have limited impact on prices. Consumption per capita in North America is about one quarter of that in Japan and there is potential for market demand to increase with the availability of fresh fish

year round and with increased advertising. Per capita consumption of fish and shellfish for selected countries is summarized in table 11.

TABLE 11

CONSUMPTION OF FISH AND SHELLFISH PER CAPITA

	Canada	U.S.
Edible weight (kg per capita) (1)		
1970	4.9	5.4
1985	6.4	6.5

Live weight equivalent (kg per capita) (2)

Japan	86 kg
Norway	49
France	24
Canada	21
U.S.	17
West Germany	15

Note: Excludes consumption of recreationally caught fish and shellfish.

Source:

1. Statistics Canada, Apparent Per Capita Food Consumption in Canada, catalogue 32-230.

2. Fisheries of the United States, U.S. Department of Commerce, Washington, D.C. April 1987.

. While prices will have to remain close to existing levels for these production levels to materialize, salmon farms will also be required to contain production costs. The foreign exchange rate between Canada and other producing countries is an important factor in assessing the competitiveness of the industry in the U.S. markets. This scenario assumes the relative rates of exchange will continue as they are now.

. Feed costs are also important in assessing the competitiveness of the various regions since they account for approximately 40 to 50% of direct production costs. This high growth scenario assumes that the cost of feed in B.C. will remain approximately the same relative

to the cost paid by other countries. This is a reasonable assumption given that B.C. producers already pay world prices for fish meal and fish oil. In 1988, the B.C. Salmon Farmers Association completed a study of feed availability. The findings of this study are summarized below:

- The B.C. farmed salmon industry may consume all of the herring meal production in Canada as early as 1989;
- Potential domestic sources of fish feed include Pacific hake, capeline from Newfoundland, and unused herring carcasses that are a by-product of the roe fishery; and
- The forecasted demand for fish meal and oil by the B.C. salmon farming industry is less than one percent of the world production of these commodities in 1985. Accordingly, the B.C. industry will likely be able to obtain fish meals and oils on the world market. B.C. will not be at a disadvantage relative to other farmed salmon producers except for Chile which is a major exporter of fish meal.

. This scenario assumes that the industry will not suffer major widespread disease related problems. Plankton blooms and other diseases such as those experienced in Norway in 1987 will occur. However, it is assumed that these occurrences will be localized and affect a small percentage of industry production in any given year.

. The high growth scenario is based on the current technology of net pens operating in sea water. Technological changes and particularly the feasibility of land based and other systems could improve the profitability of the industry and result in higher than projected growth. The B.C. industry is currently experimenting with various land based techniques and other systems and they are expected to remain at an experimental stage for the next two to three years. If successful, land based and other techniques may eventually displace the current systems. However, it is unlikely that these techniques will have any significant impact on production until 1995.

. The achievement of this production level assumes that the new entrants will succeed in obtaining capital during the early years of development. This is a plausible assumption particularly once the industry has proved its profitability. Concentration in the industry may develop, however, as established companies finance the development of new sites while smaller operations continue to be prevented from expanding because of the relatively large initial capital requirement. Rationalization may also occur through mergers and acquisitions, but this will likely impact on the number of companies and the ownership structure rather than the number of sites and production levels.

In summary, by the year 2000, the B.C. salmon farming industry has the potential to produce about 50,000 MT, or between 50 and 80% of B.C.'s commercial catch of wild salmon. For these projections to materialize, salmon prices will have to remain close to existing levels and the industry must become profitable and maintain production costs at or below current levels. The next section presents a low growth scenario for the industry.

Low Growth Scenario

Outlook to the Year 2000:

British Columbia currently has about 125 operating sites with an estimated capacity of about 21,000 MT. Under a worse case scenario, the B.C. farmed salmon production will continue to grow for the next five to seven years up to say 20,000 MT and then plateau as increased farmed fish production is achieved world wide. Production will continue to increase to say 25,000 MT by the year 2000 but primarily because the industry will mature and produce at full capacity. Under this scenario, the number of sites will likely increase to say 175 by the year 2000 and employment will level off at about 1,000 workers.

Assumptions:

This scenario assumes that the growth in farmed salmon production will be negatively impacted by production problems particularly in the next five to seven years. The industry is subject to significant risks related to plankton blooms and other diseases. Research and development by governments and individual farms is essential to allow the industry to grow and reach its production potential. The current profitability of some existing farms seems to indicate that production constraints are not insurmountable although Norwegian producers have recently incurred losses resulting from diseases and plankton blooms despite the relative maturity of their industry.

The low growth scenario assumes that market constraints will limit the growth of the B.C. industry, particularly in 1995 and beyond. Industry production is probably immune from market constraints for another five to seven years:

- Although there are other countries in the same start-up position as B.C., production from these countries is unlikely to increase at a much faster rate than in B.C. Countries in a similar start up position as B.C. include New Zealand and Chile.

- The industry is very knowledge and technology intensive. This creates some barriers to entry for other countries which are not yet active in the industry.

- The State of Alaska, a potential major competitor to B.C. has instituted a moratorium on farmed salmon production for fear of damaging the wild fishing stocks. Provided that these fears prove unfounded, the State of Alaska may become a major producer of farmed salmon by the end of the 1990's.

- The States of Washington and Oregon may also become major producers of farmed salmon, particularly if land based and other less pollution prone systems prove economically feasible. In the near future, however, these regions are not likely to become major players in the industry. The coast line of these states is more populated than in B.C. and industry growth is being constrained by opposition from environmental groups and local residents.

- The production of farmed salmon will probably double by the year 1995 which will increase the supply of salmon worldwide by about 100,000 MT. This scenario assumes that prices will drop significantly more than the 20% price drop experienced between 1986 and 1987 in B.C. when wild salmon catches varied by about 33,000 MT. This scenario assumes that existing sites will be able to continue to cover operating costs despite the drop in salmon prices. However, while existing farms will cover operating costs, investments in the industry will likely slow considerably, thereby restricting future production. Moreover, such a price drop could be devastating for farms in a start-up position, which could result in mergers and acquisitions.

  The assumption that existing farms could withstand a significant price drop is reasonable. In late 1986, the Ministry of Agriculture and Fisheries estimated the cost of farmed salmon to be in the range of C$ 4.50 per kg, compared to a price per kg at the farm gate of about C$ 9.00 per kg for a large size fish.

Although the B.C. industry is unlikely to be constrained by market forces until the year 1995, beyond that time, market demand and increased competition from other countries could jeopardize the growth of the industry:

- B.C. is likely to face increasing competition from the U.S. Pacific Northwest and Alaska in the U.S. market. This is particularly the case if land based producing techniques prove profitable, and environmental impacts are no longer a major concern.

- B.C. could lose some of its current cost advantage relative to Chile and other developing countries. At the present time, the technology is not well known and B.C. benefits from a well educated labour force. As the industry matures, less developed countries could become more competitive particularly as the cost of labour in those countries is much less than labour costs in North America.

- The production costs for farmed salmon in B.C. may increase particularly if the industry becomes more unionized thereby resulting in increased wages and salaries. Higher feed costs are also a possibility.

- The market for salmon may face increasing competition from the farming of other fin fish including trout, halibut, and cod. As a result, prices for farmed salmon could drop sufficiently to reduce the attractiveness of the industry. The production of trout is currently very large in certain countries including the United States, France and other EEC countries. While the production of other fin-fish like cod and halibut is currently at an experimental stage, commercial farms will likely begin operation within the next five years. Depending on the feasibility of these operations, increased production of these products could have a negative impact on salmon prices.

- The market for salmon could also become saturated if the industry fails to attract North American consumers to the product. As described earlier, North Americans consume very little fish on a per capita basis compared to the Japanese. The industry is relying on this gap narrowing. However, encouraging consumers to eat more fish will require extensive marketing.

- The market for farmed salmon could also be negatively impacted if the product is perceived by consumers to be of lower quality or potentially unsafe.

- The market for farmed salmon could also be negatively impacted by more aggressive marketing by wild salmon producers.

Medium Growth Scenario

A middle-of-the-road scenario is for the British Columbia industry to reach a production level of about 35,000 MT by the year 2000. Under this scenario, by the year 2000, there would be about 300 sites in operation employing an estimated 1,800 employees.

This scenario essentially presents a mid-point between the high and low growth scenarios. Major underlying assumptions are as follows:

- Production problems may limit the growth of the industry in the next 5 to 7 years thereby delaying significant investments in capacity. Current capacity is estimated at around 21,000 MT but production is still only a fraction of this capacity. Salmon farm production is subject to diseases and other risks such that it could take until 1995 for the industry to reach its capacity and produce 25,000 MT.

- Disappointing production results in the next 5 to 7 years will impact negatively on investments as banks and private investors will be reluctant to invest in the industry. This will delay the growth in the number of sites and in production.

- This scenario assumes that investments will be strong beyond 1995 as B.C. resolves some of its production related problems within the next 5 to 7 years. Because of the time lag in producing farmed salmon and producing at capacity, investments made between 1995 and 1997 will only start paying off by the year 2000.

- B.C. may face increasing competition from the United States and other countries. This is particularly likely if B.C. has production related problems which are not experienced in Chile, Scotland and Norway. In that case, these countries will be the recipients of foreign and domestic investments rather than B.C, at least until 1995 or so, when B.C. has succeeded at resolving its major production problems. This scenario assumes that markets for farmed salmon will remain sufficiently strong throughout the 1990's to encourage further investments in capacity.

CONCLUSION

In conclusion, the B.C. salmon industry will probably achieve a production rate of between 25,000 and 50,000 MT by the year 2000. The number of sites operating in B.C. is expected to range between 175 and 400 and

direct employment is likely to be between 1,050 and 2,400. This excludes indirect employment which will result from industries supplying the industry such as hatcheries and equipment manufacturers.

These production projections are consistent with the world wide farmed salmon production forecasts to the year 2000, which were developed by the DPA Group for the Department of Fisheries and Oceans. In their report, DPA estimated B.C.'s production to reach 25,500 MT by 1995 and 33,000 MT by the year 2000.

CHAPTER 2 - THE SALMON FARMING INDUSTRY IN EASTERN CANADA

HISTORICAL DEVELOPMENT OF SALMON FARMING IN EASTERN CANADA

The salmon farming industry in Eastern Canada is concentrated in the Bay of Fundy in New Brunswick and to a lesser extent in Nova Scotia. Attempts to grow salmon in sea cages in Eastern Canada were undertaken in Nova Scotia in 1969 and in New Brunswick in the 1970's. These attempts were unsuccessful because of extreme water temperatures in the winter. The first successful trials were conducted in the late 1970's at Lord's Cove on Deer Island N.B. with funding assistance provided by governments and industry.

The following table summarizes the number of sites and volume of salmon aquaculture production in the Bay of Fundy on the New Brunswick coast between 1979 and 1988. Historical salmon production for Nova Scotia and other Atlantic provinces during that period was not significant.

TABLE 12

SALMON AQUACULTURE PRODUCTION IN THE BAY OF FUNDY, NEW BRUNSWICK, 1979 - 1988

Year	Number of farms	Production (MT)	Average Price/kg ($)	Value ($000's)
1979	1	6.3	7.78	$ 49
1980	2	11.3	7.26	82
1981	4	20.8	7.50	156
1982	5	38.1	8.27	315
1983	5	68.0	9.93	675
1984	10	222.2	11.58	2,572
1985	20	349.2	12.02	4,197
1986	28	634.9	12.72	8,078
1987	34	1,315.2	14.00	18,415
1988	34	3,000.0*	12.10*	36,300*

* - estimate

Source:
Robert H. Cook, 'Salmon Aquaculture in the Bay of Fundy: A Quiet Success' Aquaculture Association of Canada; Edition 88-2, June, 1988.

1988 estimates: discussions with industry.

As shown on table 12, there are currently 34 operating salmon farms in the Bay of Fundy. Together these farms are expected to produce 3,000 MT of salmon in 1988.

The average Bay of Fundy salmon farm employs five employees and it has a production capacity of 140 MT. This is based on each farm utilizing an average of 16 cages, 2,500 to 3,000 fish per sea cage, an 88% survival rate, and an average weight of 8 lbs per marketable fish sold[1]. Given that there are 34 sites currently in operation and an average production capacity of 140 MT per farm, the existing capacity of the industry is therefore estimated at 4,800 MT. As is the case in British Columbia, fish production is still smaller than capacity because of the lead time required for salmon to reach marketable size and because farms do not necessarily stock at full capacity during start-up.

The salmon farming industry in Nova Scotia is smaller than in New Brunswick. In Nova Scotia, there were 13 operating marine sites which reported growing salmon in 1988, ten of which also produced rainbow trout in sea cages. In addition, there are 10 hatcheries, two of which produce only salmon smolts while the other eight produce rainbow trout as well as salmon smolts.

In 1987, the production of farmed salmon in Nova Scotia was estimated at 37 MT (excluding marine rainbow trout). Production data for 1988 are not available although estimates are as high as 700 MT, based on the previous year's smolt production. By comparison, the New Brunswick production of farmed salmon was 38.1 MT in 1982, 68.0 MT in 1983 and it only exceeded 600 MT, four years later in 1986. The Nova Scotia production estimate of 700 MT does not consider the survival rates and the production and marketing plans of the individual farms such that a more conservative estimate may be around 150 MT. A much different production estimate for

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[1]Robert H. Cook, 'Salmon Aquaculture in the Bay of Fundy: A Quiet Success' Aquaculture Association of Canada; Edition 88-2, June, 1988

1988 would impact on the farmed salmon production projections to the year 2000 for Nova Scotia.

Salmon farming in Quebec and P.E.I. is limited to land based facilities because of severe winter water temperatures and ice. There is one land based commercial Atlantic salmon farm in the Baie des Chaleurs in the Gaspe peninsula and another one in Georgetown, P.E.I. Another land based farm is currently under construction in Nova Scotia.

Salmon aquaculture in Newfoundland is at an experimental stage. The industry suffered a major setback in 1988 when about 450,000 farmed salmon, smolts, and market fish were destroyed because of infection. This represents virtually all of the stock of farmed salmon in Southern Newfoundland. There is only one hatchery in Newfoundland and it is attempting to start growing smolts again using eggs from the Baie des Chaleurs (Quebec) as well as the Bay of Fundy (New Brunswick).

CONSTRAINTS

The following describes the major constraints facing the industry in Eastern Canada in a number of areas, namely:

- Site availability;
- Smolt production;
- Financing;
- Attitudes of other interest groups;
- Production; and
- Marketing.

Site Availability

The major constraint facing the growth of the salmon farming industry in Eastern Canada is the limited availability of suitable sites for sea cage operations. Most of the coastal Atlantic regions have proved too cold for rearing salmon. Also, cage sites which may be suitable for rearing salmon for a number of years can experience lethal temperatures in particularly cold years.

Throughout Eastern Canada, suitable sites for sea cage operations are limited to the Bay of Fundy in New Brunswick, and particularly in a small area near Passamaquoddy Bay, as well as along the coast of Nova Scotia, mainly to the west of Halifax. Even in these regions, however, there is a risk that a particularly cold winter could prove lethal for the fish.

The limitations relating to a lack of suitable sites for sea cage farming will restrict production from Eastern Canada unless land based systems prove to be cost effective. There are some instances of land based farms in Eastern Canada, although their overall profitability is still in question:

- As mentioned earlier, the only salmon farm in Quebec is a land based operation and its success is likely the result of the farm being fully integrated. The farm produces its own feed as well as its own smolts.

- Prince Edward Island has one of the largest indoor salmon and trout growing facilities in the world. Located in Georgetown, the facility was built by Norwegian and Canadian investors with financial assistance from the federal government which approved a loan guarantee for $3 million and a low interest rate of five and three eighths percent. The province also allocated some job creation grants. The original investor recently incurred financial troubles and the farm is being operated by the receiver until it can be sold to a third party.

Smolt Production

Smolt production has restricted the growth of the industry in New Brunswick even though such production has been expanding rapidly. There are now four major hatcheries and eight medium to small hatcheries in

operation. The shortage of smolts may continue to limit farmed salmon production in the near future. However, the recent lifting of the moratorium on leasing crown land for hatchery development should attract investors to this sector and provide significant supplies of eggs and smolts to salmon farmers in the longer term. Smolt production in Nova Scotia has not restricted industry growth to the same extent.

In Newfoundland smolt production has been a major limiting factor to industry growth. As mentioned earlier, a recent infection resulted in the destruction of virtually all of the stock of farmed salmon in southern Newfoundland. Moreover, fish farms in Newfoundland have had disappointing results due to slow growth rates and early maturity of the fish. The Bay d'Espoir hatchery is now importing smolts from other provinces to rebuild its stocks.

Financing

The lack of financing available to salmon farms particularly during the start up years has been a concern.

Attitudes of Other Interest Groups

Environmental issues are of concern primarily in the Bay of Fundy area where the industry has been more concentrated. In that region, the rapid growth of sea cages has raised opposition from the traditional fishery. The weir fishery is concerned that sea cage operations may deter sardine schools from moving inshore and entering the weirs. Also, local clam diggers are concerned that sea cage operations could impact negatively on adjacent commercial clam flats.

Production Related Factors

As is the case in B.C., there are a number of diseases which can limit production and affect mortality rates, including some diseases such as ulcerative dermal necrosis (UDN), which has not yet been found in Canada but has devastated many Atlantic salmon populations in Europe. The

industry, however, has been monitoring the development and the occurrence of diseases and improving on vaccines administered to fish.

Marketing

Markets have not restricted industry growth up to this stage. As indicated, world supplies of salmon are expected to increase by about 400,000 MT by the year 2000, primarily because farmed salmon production world wide is expected to quadruple. Unless this supply increase is matched by an increase in demand, salmon prices will face downward pressures over the next decade.

STRENGTHS OF THE INDUSTRY

The comparative advantages of Eastern Canada are discussed in the following sections in a number of areas namely:

- . Proximity to markets;
- . Production costs;
- . Experience and infrastructure; and
- . Government regulations;

Proximity to Markets

Except for Newfoundland, the Atlantic provinces are in close proximity to Montreal and Toronto as well as the Eastern United States markets. Fish grown in the Atlantic provinces are within 6 to 12 hours of these large markets, an important advantage given that farmed salmon is typically sold fresh.

Production Costs

The cost of production of farmed salmon depends on a number of factors including the mortality rate, farm capacity, cost of feed, cost of labour, and cost of capital. The possibility of winter kills in Eastern Canada waters including the Bay of Fundy increases the risks of farming in that region. Notwithstanding that risk, however, the costs of producing farmed salmon in Eastern Canada is competitive.

The Atlantic provinces have one of the major herring fisheries in the world. As a result, there are already some manufacturers of moist, as well as dry feeds, and additional feed manufacturing capacity is being planned.

Labour costs in Eastern Canada are also competitive. In a study which was conducted in 1988 on behalf of the Department of Fisheries and Oceans and the New Brunswick government[2], fish farm employees were reported to earn an average of $19,200 a year including benefits, which is probably slightly lower than the cost of labour in B.C. This is also lower than the cost of labour in Norway of C$ 25,000 but it is higher than the C$ 13,000 paid in Scotland. Wide fluctuations in exchange rates can significantly affect the relative production costs between countries in any given year.

The 1988 operating costs before interest and taxes of farmed salmon for New Brunswick are estimated at $6.40 per kg once the farm is at full production (as reported in the above mentioned study of the industry in that province). This compares to a 1986 estimated cost of production in B.C. of about $4.50 per kg. The variance is primarily due to differences in species and the higher cost of Atlantic smolts compared to Pacific fish. In that same study, prices for Atlantic salmon are estimated at approximately $13 per kg which gives some cushion for prices to drop if markets deteriorate.

Expertise and Infrastructure

The industry in Eastern Canada has a well trained labour force, a large pool of research scientists and an extensive network of hatcheries and other organizations supplying the industry:

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[2]Economic Assessment of Salmonid Cage Culture Industry in Southwestern New Brunswick, prepared by Fiander-Good Associates Ltd. in association with Washburn & Gillis Associates Ltd. on behalf of the Federal Department of Fisheries and Oceans and the Government of New Brunswick, March 31, 1988.

- There are a number of large companies which have processed, marketed, and distributed fish products from the wild fisheries and are now taking an active part in the aquaculture industry.

- About 20 small to medium size growers in New Brunswick have formed a cooperative, Atlantic Silver Ltd., to market their production.

- The Atlantic provinces have widespread technical and industry knowledge in hatchery and related fields.

- The St. Andrews biological station and the demonstration farm continue to play a major role in providing technical advice and support to the industry. Other institutions including community colleges and government departments have also developed related training courses.

Government Regulations

The industry in Eastern Canada is subject to environmental regulations which are comparable with those in B.C., Norway and Scotland. In addition, the industry in Eastern Canada is subject to a number of other limiting regulations such as the New Brunswick and Quebec moratoriums on future salmon farming sites in those regions. These regulations, however, are expected to be lifted in 1989 and are not expected to limit future industry growth.

OUTLOOK TO THE YEAR 2000

This section projects the size of the salmon farming industry in Atlantic Canada under three sets of assumptions, namely, high, moderate and low industry growth. Because of the diversity of the various provinces, projections have also been developed for each province whenever possible. These projections are presented in the table following and are described in the following paragraphs.

TABLE 13

OUTLOOK TO THE YEAR 2000

SALMON INDUSTRY IN EASTERN CANADA

	Production		Number of Sites		Employment by Fish Farms	
	1995	2000	1995	2000	1995	2000
New Brunswick:						
High	8,000	10,000	75	75	375	375
Medium	6,000	7,500	55	55	275	275
Low	4,000	5,000	35	35	175	175
Nova Scotia:						
High	1,500	3,000	15	30	75	150
Medium	1,000	1,800	10	15	50	75
Low	300	500	1	2	10	20
Quebec/P.E.I. Newfoundland/:						
High	1,500	3,000	5	10	50	100
Medium	1,000	1,700	4	6	40	50
Low	300	500	2	2	20	20
Total Eastern Canada:						
High	11,000	16,000	95	115	500	625
Medium	8,000	11,000	69	76	365	400
Low	4,600	6,000	38	39	205	215

Note:

These projections assume that the current technology of net pens operating in sea waters continue to be the most prevalent technology used in salmon farming. Technological changes and the widespread adoption of land based systems could result in much higher production projections.

High Growth Scenario

The province which shows the most potential for growth is New Brunswick, followed by Nova Scotia, Quebec, P.E.I. and Newfoundland. Under high growth assumptions, Eastern Canada is estimated to produce 16,000 MT of farmed salmon by the year 2000, with about 10,000 MT coming from New Brunswick, 3,000 MT coming from Nova Scotia and another 3,000 being produced in land based facilities in Quebec, P.E.I. and Newfoundland.

These projections assume that the current technology of net pens operating in sea waters will continue to be the most prevalent technology used in salmon farming. Technological changes and the widespread adoption of land based and other systems could result in higher than projected growth throughout Eastern Canada. Land based systems are technically feasible, but their viability has yet to be established. The attractiveness of land based systems relative to sea cages will be determined over the next three to five years.

If the profitability of land based techniques materializes, proximity to markets could become one of the determining factors in location decisions. Eastern Canada has a distinct advantage over Norway, B.C., Chile and other producing countries in supplying the Quebec, Ontario and eastern U.S. markets. Eastern Canada, however, is at a disadvantage relative to B.C. and the U.S. Northwest in supplying Japan, one of the larger potential markets.

The following paragraphs review the projections on a provincial basis.

New Brunswick:

Industry growth in New Brunswick is expected to be limited by the number of sites which are suitable for salmon farming production in sea cages. Existing salmon farms are concentrated in one small area near Passamaquoddy Bay in the Bay of Fundy. The maximum number of potential sites in that region is estimated by industry and local governments to be around 75, compared to the 34 existing operating sites. In September

1986, the New Brunswick government placed an indefinite moratorium on new leases for aquaculture sites to allow time for the development of a comprehensive strategic plan for industry. The moratorium is expected to be lifted within the next few months and new sites will be able to begin production in the near future.

Assuming that New Brunswick can sustain these 75 operating sites for cage operations, farmed salmon production in that province will reach as much as 8,000 MT of farmed Atlantic salmon by 1995, or more than double the estimated 1988 production of 3,000 MT. By the year 2000, production is expected to increase to about 10,000 as the 75 operating farms reach their maximum capacity level. Under this scenario, employment at the fish farms will increase to the equivalent of 375 full-time persons or about 5 employees per farm, which is the estimated average employment per existing farm in New Brunswick.

These production projections assume an average capacity level of 140 MT per site, which is the average holding capacity of existing sites in New Brunswick. This projection also assumes that by the year 1995, only about half of the farms will be operating at full capacity with the other half producing about 70 MT or about 50% of available capacity. Thus, in 1995 the industry will have a production capacity of about 10,500 MT (75 sites of 140 MT per site) yet production will be around 75% of this capacity at 8,000 MT.

For New Brunswick to reach this production level, there are a number of other conditions which will have to be met:

- The production of farmed salmon in New Brunswick will have to prove feasible on a long term basis. A cage site which may be suitable for rearing salmon for a number of years can experience lethal temperatures in particularly cold winters. This scenario assumes that the industry will not be impacted by a severely cold winter which could kill a large percentage of the salmon stock and deter future investments.

- This scenario assumes that prices for salmon will remain around existing levels at least for the next three to five years to

stimulate further investment in the industry. World supplies for salmon are expected to increase by almost 50% by the year 2000; this scenario assumes that the demand for fish will increase to meet the supply and that prices will remain near the current levels through to the year 1995.

Provided that salmon prices remain fairly stable through to the year 1995, New Brunswick producers will likely be able to support a price decline beyond that time. These projections assume that much of the investment will take place prior to 1995. Accordingly, as long as prices are sufficiently high to cover operating costs, established producers will likely continue to operate. A recent study conducted on behalf of the federal and provincial governments estimated that a salmon farm in New Brunswick has operating costs of about $6.40 per kg. Since prices are estimated at around $13 per kg, this gives some cushion for prices to decline.

. This scenario assumes that the cost of feed in New Brunswick will remain approximately the same relative to the cost paid by other countries. This is a reasonable assumption given the availability of unused herring carcasses that are a by-product of the Atlantic herring roe fishery.

. Lastly, these projections assume that the industry will succeed in obtaining capital during the early years of development. This is a plausible assumption provided that the existing operations prove to be profitable.

Nova Scotia:

There are currently three marine farms in Nova Scotia which exclusively grow salmon and another 10 which grow both marine rainbow trout as well as salmon. There is also one land based farm under construction.

Salmon farms in Nova Scotia produced 37 MT of farmed salmon in 1987. Production data are not available for 1988, but estimates are as high as 700 MT, based on the previous years smolt production. As mentioned earlier in this chapter, a 1988 production estimate of 150 MT is more conservative given the infancy of the Nova Scotia industry. The achievement of a significantly different 1988 production level would have an impact on the production projections. Production projections are as high as 1,500 MT by the year 1991 based on the number of fish currently being reared and the holding capacity of operating farms. Given the

infancy of the industry in Nova Scotia, a production level of 1500 MT is more likely to be reached by 1995 than 1991:

- The industry is likely to have at least some setbacks relating to lethal water temperature and diseases.
- The growth and survival rates for salmon are usually lower than expected in the development years of an industry.

Other conditions which will be required for Nova Scotia to reach this production level by 1995 include:

- Stable prices and production costs.
- Relatively mild winters at least initially such that existing producers do not suffer significant losses.
- Ability for new entrants to obtain financing.

Provided that the 1500 MT production level is reached by 1995, Nova Scotia will potentially double this production level by the year 2000. This projection is based on the following assumptions:

- Prices will remain stable beyond 1995 and through to the year 2000, so as to encourage investments in salmon farming in that province. Because of the investment required beyond 1995 to achieve the 3,000 MT level, the high growth scenario for Nova Scotia is more dependent on prices than for New Brunswick, where the bulk of investments will be made in the early 1990's.
- Profitability in the industry will materialize by 1995 which will encourage investment in the industry.
- Operating costs in the industry, particularly those relating to feed and labour, will remain constant.

The number of operating sites required to achieve these production levels depends on the holding capacity per site. As mentioned earlier, there are 13 sites which grow salmon in sea cages. However, only three exclusively grow salmon while the other 10 also grow marine rainbow trout. A high growth estimate is for the number of sites which primarily grow salmon to increase to 15 by 1995 and to 30 by 2000. This is based on the following assumptions:

- 140 MT holding capacity, or about the same size as in New Brunswick.
- a 75% utilization rate based on half the farms operating at capacity and the other half operating at about half of total capacity.

Farm related employment resulting from these production levels would be 75 by 1995 and 150 by the year 2000 based on five employees per farm.

Quebec/Newfoundland/P.E.I.:

Salmon farming in Quebec and P.E.I. is limited to land based facilities because of cold water temperatures and icy conditions in the winter.

The same holds true for Newfoundland except perhaps in the Bay d'Espoir area where there are experiments underway regarding rearing salmon in sea cages.

There are limited opportunities for each of these provinces to expand the salmon farming industry, primarily because land based facilities are capital intensive and their economic feasibility is still in question.

Given these limitations, the development of salmon farming in these locations will be on a selected basis, as is the case now with the farm in the Bay des Chaleurs and the one in Georgetown, P.E.I. Under high growth assumptions, production of farmed salmon from these regions is expected to reach 1,500 MT by 1995 and 3,000 MT by the year 2000. Through to the year 1995, the facilities in Georgetown, P.E.I. and the Bay des Chaleurs are likely to produce the majority of the salmon production and the number of sites is expected to be around five:

- There are no other major land based facilities being built in these provinces. Given the time lag for land based facilities to reach full production, production from new facilities would not be significant over the next few years.
- The facility in P.E.I. was largely funded by governments; further public sector investments will probably depend on the success of the operation in Georgetown, especially since the farm is now in receivership.

Provided that these facilities prove profitable by 1995, there will likely be further investment in other land based facilities. Under these conditions, production will increase to 3,000 MT by the year 2000 with the number of sites increasing to about ten.

Employment from these facilities by the year 2000 is expected to be about 100 full-time positions or about ten employees per site. This is twice the average employment in the other provinces as sites will be land based and thus potentially larger.

Low Growth Scenario

Under the low growth assumptions, the production of farmed salmon from Eastern Canada will increase to 4,600 MT by 1995 and to about 6,000 MT by the year 2000, or about double the production level expected for 1988. Under this scenario, the bulk of the production will originate from New Brunswick with Nova Scotia, Quebec, P.E.I. and Newfoundland producing insignificant amounts:

- The total number of sites in New Brunswick may remain around 35 sites, particularly if some of the 34 operating sites prove unsuitable for salmon production in the long run.

- One or more of the land based operations in Georgetown, Quebec and Nova Scotia may shutdown if the operations prove to be unprofitable. Alternatively, these operations may select to rear only marine rainbow trout depending on market conditions. The cost of raising trout is lower than salmon as trout can sustain much higher densities, a factor which also reduces the cost of producing the smolts. Current prices for salmon are sufficiently higher to justify growing salmon rather than marine rainbow trout. However, this situation could change if salmon prices drop as a result of increases in world supplies of farmed salmon.

- Attempts to grow smolts in Newfoundland may continue to be uncertain.

Medium Growth Scenario

A middle-of-the-road projection is for the Eastern provinces to reach a production level of about 8,000 MT by 1995 and 11,000 MT by the year 2000. Of the 11,000 MT produced in the year 2000, about 7,500 MT will be produced in New Brunswick, 1,800 in Nova Scotia and 1,700 MT in the other three provinces.

This scenario presents a midpoint between the high and low growth scenarios, as summarized below:

- The number of operating sites in New Brunswick will increase to 55 from 34 existing sites. As mentioned earlier, the major constraint here will be the number of suitable available sites in the small area near Passamaquoddy Bay.

- Production in Nova Scotia will increase to 1,800 MT by the year 2000 and the number of operating sites which grow primarily salmon will be about 10 in 1995 and 15 in the year 2000. However, there may be a larger number of sites growing a combination of salmon and marine trout. As mentioned earlier, Nova Scotia reports three sites which grow salmon exclusively but another ten also grow salmon, in combination with marine rainbow trout.

- The land based facilities in P.E.I., Quebec and Nova Scotia will continue to operate but further investments in other land based facilities would be limited. Under these conditions, production will reach 1,000 MT by 1995 and 1,700 MT by the year 2000. This scenario accounts for one other land based site to be built in Quebec, P.E.I. or Newfoundland by 1995 and another two by the year 2000.

CONCLUSION

In conclusion, the salmon industry in Eastern Canada will probably achieve a production rate of between 6,000 MT and 16,000 MT by the year 2000 with New Brunswick accounting for about 60% of this production in the high growth scenario and about 80% under low growth assumptions. The number of sites operating in Eastern Canada is expected to range between about 40 and 115 and direct employment is likely to be between about 215 and 625. This excludes indirect employment which will result from a supporting

infrastructure supplying the industry such as hatcheries and equipment manufacturers.

These production projections are consistent with the world wide farmed salmon production forecasts to the year 2000, which were developed by the DPA Group for the Department of Fisheries and Oceans. In their report, DPA estimated Eastern Canada's production to reach 4,500 MT by 1995 and 6,000 MT by the year 2000.

CHAPTER 3 - THE OYSTER INDUSTRY IN B.C.

HISTORICAL DEVELOPMENT IN THE PACIFIC OYSTER INDUSTRY

The culture of Pacific oysters in British Columbia started at the beginning of the century when the Pacific oyster was imported from Japan for cultivation. However, little cultivation of Pacific oysters took place until the native B.C. oyster stocks were depleted. Commercial oyster production began in the late 1950's and peaked in 1963 at 5,900 MT.

Production of cultured oysters declined in the years following this peak harvest, reaching a low production level of 1,415 MT in 1981. This decline in production was primarily due to declining productivity in the major growing areas because of poor bottom culture practices and the reliance on natural spat nursery and wild harvest techniques. Historical production for B.C. is presented in table 14.

TABLE 14

B.C. OYSTER PRODUCTION 1977 - 1987

	Lease Holders	Issued Licences	Production Tonnes	Percentage Change Increase	Value $000s	Average Production Per Site
1977	71	177	2,998	%	$ 981	16.9
1978	78	202	2,793	(7)	1,021	13.8
1979	80	208	2,231	(20)	893	10.7
1980	101	239	1,922	(14)	1,134	8.0
1981*	114	250	1,415	(26)	1,030	5.7
1982*	145	282	1,579	12	981	5.6
1983*	164	303	2,453	55	1,554	8.1
1984*	168	310	2,897	18	2,109	9.3
1985*	188	334	3,420	18	2,613	10.2
1986*	200	350	2,864	(16)	2,500	8.2
1987P*	249	385	3,000	5	$3,000	7.8

P - Preliminary.
* - Includes a small harvest of wild oysters from picking permits.

Source:

Province of British Columbia, Ministry of Agriculture and Fisheries.

As shown in table 14, while oyster production declined between 1977 and 1981, production increased in the 1980's, because of the development of hatcheries, the adoption of better technology for seeding and the increasing use of off-bottom production methods. This is also reflected in the increasing number of leaseholders and licenses over the period.

Off-bottom oyster culture refers to methods of growing oysters by suspending them from surface floats over deep water. The advantages of off-bottom cultures over bottom (beach) cultures include:

. Faster growth;

. Higher yields per unit of water surface area;

. Lower mortalities; and

. The production of a more visually appealing oyster.

The main disadvantage is that off-bottom methods require larger capital costs and that growers are required to remove fouling (unwanted organisms attached to the oysters) during grow out or at harvest.

The industry in B.C. operates under the controls of the B.C. Oyster Board. The Board sets minimum selling prices of domestically grown oysters and determines the allowed markup by wholesalers. The B.C. Oyster Board has no authority on import prices and B.C. producers face strong price competition from their counterparts in the United States. The following table shows total imports of fresh and frozen oysters for Canada and B.C.

TABLE 15

CANADIAN IMPORTS OF OYSTERS, 1973 - 1985
(Tonnes)

Year	Fresh and Frozen		Canned Oysters	
	Canada	B.C.(1)	Canada	B.C.(1)
1973	863	N/A	N/A	N/A
1974	711	51	N/A	N/A
1975	467	61	1,333	731
1976	597	86	1,232	574
1977	490	72	1,286	651
1978	570	79	1,185	500
1979	614	108	879	471
1980	710	176	960	639
1981	757	202	1,032	553
1982	740	243	1,343	732
1983	720	223	1,213	661
1984	644	182	1,422	805
1985	708	232	1,427	793

Note:

1. Included in the Canadian Data.

Source:

B.C. Oyster Production and Marketing - An Overview, B.C. Ministry of Agriculture and Fisheries, 1986.

Imports by Commodity, Statistics Canada. Figures include shell stock.

As shown by table 15, B.C. imports about 200 MT of fresh and frozen oysters and about 800 MT of canned oysters. This compares with the production of 3,000 MT for 1987. The bulk of imports of fresh and frozen oysters comes from the U.S., primarily Washington State and Oregon. B.C. also imports canned oysters from Korea, the Philippines and China.

B.C.'s oyster production is a small portion of total world production. The major producing countries include Japan, which produced in the order of 250,000 MT, and France which produced 107,300 MT in 1985.

Employment in the oyster industry in B.C. is estimated to be the equivalent of 100 full-time jobs. This is based on the following assumptions:

- Labour costs account for about 40% of the production wholesale value of about $3 million.
- Labour costs in B.C. of about $8.00 per hour.
- An estimated 1,500 hours per full-time job - based on 30 hours a week and 50 weeks per year.

Although the number of full-time job equivalents is estimated at about 100, the total employment is much larger because of the seasonality of the industry. The B.C. Ministry of Agriculture and Fisheries estimates that employment related to the oyster industry may be as high as 500 or two employees per lease holder.

CONSTRAINTS FACING THE INDUSTRY

The industry in B.C. faces a number of constraints. These include:

- **Site Availability.** Most sites which are suitable for bottom culture have already been leased and the industry has been constrained by the lack of available sites. However, off-bottom culture methods are less dependent on the characteristics of the foreshore ocean bottom and they offer considerable opportunities for development.
- **Availability of seed.** Seed oysters may come from either wild or hatchery sources. Wild seed is obtained by placing suitable collectors in waters where heavy natural sets are known to take place. Seed may also be created in hatcheries although research is continuing to improve the setting and post setting success in hatchery environments. There are four primary seed suppliers in B.C., two of which also produce larvae. These suppliers cannot meet the local demand, and most larvae and hatchery seed required by the industry are imported into the province, principally from Washington State.

- **Labour costs.** Oyster farming is a labour intensive process. Hourly wages in B.C. range between six and twelve dollars per hour depending on the degree of isolation, but most labourers get eight to nine dollars per hour, including benefits. Although labour costs in B.C. are comparable to those in the U.S. they are substantially higher than labour costs in South East Asia. This reduces the potential for import displacement of canned oysters.

- **Pollution and diseases.** Pollution in B.C. is not as severe as in the United States but it has caused abandonment of a number of beach leases and has affected the supply of wild seed in certain areas.

- **Financing.** Most good bottom sites have been leased and the potential for industry growth will require the use of capital intensive off-bottom methods. Cash flow is also a problem as oysters typically require about two years to reach marketable size. Raised on a diet of cultured microalgae, however, the oysters can reach a size suitable for the half shell market in about nine months.

- **Markets.** Markets have not been a major constraint to growth except that B.C. producers are forced to compete with U.S. producers for the local markets. This tends to exert downward pressures on prices and restrict the profitability of the industry.

  The fact that oysters are not marketable during the summer while they spawn has sometimes hindered the industry in marketing their products. Efforts are underway to produce sterile oysters or develop genetically different types of seed whose quality does not decline during the summer.

STRENGTHS OF THE INDUSTRY

B.C. produces a small share of the worldwide production of oysters. Nevertheless, B.C. has certain competitive advantages, described as follows:

- Demand for oysters is increasing along with the demand for other fish and shellfish.

- As reported in a study on the marketing opportunities for the oyster industry conducted on behalf of the B.C. Ministry of Agriculture and Fisheries, opportunities exist for increasing sales volumes of fresh oysters in B.C. The Canadian per capita consumption of oysters has traditionally been half that of the U.S.

. Up until now, the industry in B.C. has made little effort to expand B.C. or Canadian sales through advertising or consumer awareness programs.

OUTLOOK FOR THE INDUSTRY IN B.C.

This section projects to the year 2000 the size of the oyster industry in B.C. The projections under high growth, medium growth and low growth assumptions are presented in the table below and in the paragraphs following:

TABLE 16

OUTLOOK TO THE YEAR 2000
B.C. OYSTER INDUSTRY

	Production		Number of Leases		Employment	
	1995	2000	1995	2000	1995	2000
High growth	7,000	13,000	750	1,450	230	430
Medium growth	5,500	9,000	600	1,000	180	300
Low growth	4,000	5,500	450	600	130	180

High growth

Studies indicate that B.C. waters can produce 10 to 50 times the current quantity of oysters through improved on-bottom culture methods and increased use of off-bottom leases.

Although the potential is there, industry production is unlikely to reach this potential by the year 2000:

. Obtaining hatchery produced seed is still a problem - most seed oysters are imported from the U.S.; also, the setting and post-setting process is still under research and development.

- There are limited sites suitable for on-bottom culture of the oysters and thus expansion will likely be in off-bottom production. There are no records of what proportion of production is off-bottom but the industry estimates it to be around 10% of the shucked oyster market and about 40% of the half shell market.

The production of oysters in B.C. has nearly doubled since 1981, increasing at an average production level of about 250 MT per year. However, increases varied widely from year to year, ranging from 5% in 1987 to 55% in 1983, for an average annual compounded rate of 13% over the six year period.

One possibility is for oyster production to grow at an annual rate of 13% a year through to the year 2000, or about the same rate as that experienced since 1981. Under this assumption and a 1988 oyster production of about 3,000 MT, production will reach about 7,000 MT by the year 1995 and 13,000 MT by the year 2000.

Under these production projections, the number of sites is estimated to reach 750 by 1995 and 1,450 by the year 2000. This is based on an average production of 9 MT per site, which is about the average production per site for the years 1977 to 1987 as was shown on table 14.

Under these conditions, employment in the oyster industry in B.C. will increase to 230 person years by the year 1995 and to 430 by the year 2000. This is based on an average production level of 30 MT per person per year equivalent, assuming a current production level of 3,000 MT and an estimated 100 full-time equivalent positions in the industry.

The achievement of this production level will require that:

- The exchange rate between Canada and the U.S. remains at the current level such that Canadian producers are at an advantage in competing in the U.S. market.

- The markets in Canada expand to absorb this increase in supply, or B.C. producers succeed in penetrating the U.S. markets.

- The oyster industry does not experience a major disease or contamination outbreak.

. Production costs remain sufficiently below market prices to stimulate investments in the industry. In March 1988, the B.C. Ministry of Agriculture and Fisheries estimated the cost of production by off-bottom methods to be as follows:

TABLE 17

ESTIMATED PRODUCTION COST FOR OFF-BOTTOM OYSTER PRODUCTION

	Cost of Production		December 1988
	Range	Average	Prices
Half shell ($/dozen)	$2.77-3.06	$ 2.83	$3.10
Shucked Meats ($/U.S. gallon)	$21.40-25.90	$22.44	$28.00

Source:

Aquaculture Information Bulletin No. 21, B.C. Ministry of Agriculture and Fisheries, March 1988.

Price effective December, 1988 as reported by the B.C. Oyster Board.

. As shown in table 17, prices for these products are between 10% and 25% higher than current average production costs using off-bottom methods.

. This scenario also assumes that oyster seed will remain available at or below current prices. This is a reasonable assumption as research and development in that field should reduce the cost of growing seed.

Low Growth Scenario

One possibility is for the industry to increase production at a more modest compounded rate of say 5% a year. Under these conditions, production will increase to about 4,000 MT by the year 1995 and to 5,500 MT by the year 2000. Under this scenario, the number of sites will increase to 450 by the year 1995 and to 600 by the year 2000. Employment will also increase proportionally to about 130 full-time equivalent positions by 1995 and to 180 by the year 2000.

Major conditions which could seriously restrict the growth of the industry are summarized below:

- The Canadian dollar may increase in value relative to the American dollar which could worsen the competitive position of B.C. producers relative to their counterparts in the United States.
- The costs and availability of seed from hatcheries may restrict the growth of the industry. Any increases in seed cost will reduce the profitability of the industry and potentially limit new investments.
- Financing may be a problem, particularly since off-bottom techniques create higher capital costs.
- Markets may be a problem, although under this scenario, the projected production to the year 2000 of 5,500 MT will be about equal to the 1963 production of 5,900 MT.
- This scenario assumes that the industry will not experience a major disease outbreak or contamination which could result in much lower production levels than these projected.

Medium Growth Scenario

A middle-of-the-road scenario is for the B.C. oyster industry to reach a production of 5,500 MT by 1995 and 9,000 MT by the year 2000, which is about a mid point production level between the low growth and high growth scenarios. Under this assumption, the number of leases will increase to 1,000 by the year 2000 and employment will be around 300 full-time equivalent position.

CONCLUSION

In conclusion, the B.C. oyster industry will likely see its production increasing to between 5,500 MT to 13,000 MT by the year 2000. The number of sites which are suitable for bottom culture is limited but with off-bottom production methods becoming more common, the industry has the potential to increase production significantly in the next decade. Major constraints to growth will be the availability of oyster seed and the ability of B.C. producers to compete in U.S. markets with American producers.

CHAPTER 4 - THE OYSTER INDUSTRY IN EASTERN CANADA

HISTORICAL DEVELOPMENT OF OYSTER FARMING IN EASTERN CANADA

There are two major oyster species which are cultivated in the Atlantic provinces, namely the American and the European oyster.

Summer seawater temperatures determine the spawning success and survival of the American oyster. In Eastern Canada, areas with favourable conditions include the southern Gulf of St. Lawrence and the Bras d'Or Lakes on Cape Breton Island. Water temperatures are too cold for growing American oysters in the Bay of Fundy or along the Nova Scotia coast.

Many consider the European oyster an ideal candidate for culture in the oceanic waters of the Nova Scotia coast where water temperatures are somewhat low for the American oyster. In 1987, there were three growers with established viable stocks of European oysters along the east coast of Nova Scotia. Although the European oysters can be grown along the Nova Scotia coast, they cannot grow in the Bay of Fundy (too cold) or the Gulf of St. Lawrence (too warm). The occurrence of annual blooms of the toxic dinoflagellate which causes paralytic shellfish poisoning (PSP) as well as strong tides and currents, make it impossible to grow oysters in the Bay of Fundy.

Commercial oyster production in Eastern Canada is therefore limited to New Brunswick, Nova Scotia and P.E.I. Oyster production in 1987 for these three Atlantic provinces is reported in table 18:

TABLE 18

1987 OYSTER PRODUCTION IN ATLANTIC PROVINCES

	Tonnes	Number of leases
New Brunswick	1,250	700 - 850
P.E.I.	1,300	900
Nova Scotia	29	142
Total	2,579	1,742 - 1,892

Source:

Commercial Aquaculture in Canada, Department of Fisheries and Oceans, 1988.

These production data include oyster production from the cultivated as well as the captured fishery. The breakdown between the two fisheries is not available but the proportion of oyster production which can be attributed to cultivation is estimated to be very small, with some estimates being as low as 1% of the total.

In New Brunswick and P.E.I., the majority of the leases are held by cottage sized ventures and not by commercial operations:

- In New Brunswick in 1987, while there were between 700-850 leases held, only about 12 lease holders purchased seed for grow-out on private beds and about 75% of the oyster production came from public beds.

- In P.E.I., most oysters are harvested in the spring from public beds and moved to privately leased beds for re-harvest in the fall. About 10% of the leases are held by active commercial operation.

Oyster production in Nova Scotia is relatively small relative to the number of leases primarily because the industry is in its infancy. In Nova Scotia, about 12 operations used off-bottom methods while the other 130 lease holders produced bottom-cultured oysters on private beds.

Oyster production in 1988 is not expected to have increased significantly over the 1987 level at least in New Brunswick and P.E.I. This is primarily because the industry in these two provinces relies heavily on wild and natural seeding.

CONSTRAINTS

Some of the constraints facing the industry in Eastern Canada are as follows:

- Limited seed supply - this has been a major impediment to industry growth in Nova Scotia.

- Long life cycle - the growth rate for the European oyster is about three to four years and for the American oyster it can be as long as six years.

- Financing - because of the long life cycle of the American and European oysters, cash flow is often a problem.

- As mentioned earlier, commercial oyster production in Eastern Canada is limited to New Brunswick, Nova Scotia and P.E.I. Within these regions, oyster production has the potential to increase significantly such that the availability of sites which are suitable for oyster farming, is unlikely to restrict production for the next decade. The off-bottom production methods increase oyster production capabilities of the region. There are also many opportunities to produce large volumes from existing on-bottom sites, particularly in Nova Scotia.

STRENGTHS

The strengths of the industry are as follows:

- The Atlantic provinces are close to the large Eastern U.S. markets. This is an important advantage for supplying the markets for fresh oysters.

- The demand for oysters is increasing along with the demand for other fish and shellfish.

- The demand for oysters in Eastern Canada has the potential to increase. The per capita consumption of oysters has traditionally been half that of the U.S. Also, the industry in Atlantic Canada

has made little effort to expand domestic sales through advertising or consumer awareness programs.

OUTLOOK FOR THE INDUSTRY

This section projects to the year 2000 the size of the oyster industry in Atlantic Canada, under high growth, medium growth and low growth assumptions. The projections are summarized in table 19 and are described in the following paragraphs.

TABLE 19

OUTLOOK TO THE YEAR 2000
ATLANTIC CANADA OYSTER INDUSTRY

	Tonnes		Full-Time Equivalent Employment	
	1995	2000	1995	2000
High growth	5,000	9,000	165	300
Medium growth	4,000	6,500	135	215
Low growth	3,000	4,000	100	130

High Growth Scenario

There is significant potential to increase the production of oysters in Atlantic Canada. With the new hatchery in Nova Scotia, there is potential for a large number of oyster farmers to enter the industry and for existing lease holders to begin producing at higher levels. The major constraints to growth will be financing and the difficulty to earn an adequate rate of return from a crop that can take as much as 6 years to harvest.

One possibility is for Atlantic oyster production to grow at the same rate as that experienced in B.C. since 1981, or about 13% per annum. The two industries are not directly comparable. Oyster farming in Eastern Canada

may grow faster than it did in B.C. because of the ability for Eastern Canada to supply the larger Eastern Canadian market and produce the European oyster, a new product in North America. On the other hand, oyster farming in Eastern Canada may grow at a slower rate than it did in B.C. because of the longer life cycle of the European and American oysters relative to the Pacific oyster. This scenario assumes that these factors will balance each other such that oyster farming in the East will grow at about 13% per annum or about the same as in B.C.

Under these conditions, oyster production will reach about 5,000 MT by 1995 or about double the current production level and about 9,000 MT by the year 2000. The achievement of this production level will require that:

- The exchange rate between Canada and the U.S. dollar does not deteriorate from current levels so Canadian producers remain competitive in the U.S. market.

- The production of European oysters increases significantly relative to total production. The European oyster takes about three to four years to grow compared to up to six years for the American oysters and between 9 and 24 months for the Pacific oyster grown in B.C. Because of the longer growth cycle of the American oyster, investment in farms growing American rather than European oysters will delay the achievement of higher production levels.

- The market in Eastern Canada expands to absorb this increase in supply, or Eastern Canadian producers succeed in penetrating the U.S. and European markets. Fresh European oysters are not available commercially in North America, but in Europe, they are viewed as a much higher quality product than the American or the Pacific oyster.

- Production costs remain sufficiently below market prices to stimulate investments. Investment in the industry has increased in the last five years with the investment in the hatchery in Nova Scotia and renewed interest in the industry. Various government incentive programs may be required for investments to continue to increase over the next decade.

- This scenario assumes that the oyster hatchery in Nova Scotia will remain viable and that seed will be available over the next decade at or below current prices. The hatchery in Nova Scotia is funded exclusively by the private sector with some European funding. In

excess of 2 million oyster seed were produced last year and the hatchery plans to produce up to 50 million oyster seed depending on demand.

. Lastly, this scenario assumes that the oyster industry does not experience any major setback relating to diseases such as the Malpeque disease which destroyed between 90-95% of the oyster stock between 1920 and 1950. The remaining oysters became disease resistant and these form the current oyster stocks.

Employment related to oyster production in Eastern Canada is not available. In B.C., about 30 MT of oyster production translates to one full-time equivalent position. On this basis, current employment in Eastern Canada is estimated at about 85 full-time equivalent positions. With production more than doubling by the year 2000, employment will be expected to increase to 165 by 1995 and to 300 full-time equivalent positions by the year 2000. However, because oyster growing is typically combined with other means of livelihood, a much larger number of people, perhaps three to four times as many, will be involved in the industry. Also, this estimate does not account for the fact that during the start-up years of an oyster farm, there will be employment but no production.

These projected production levels may not necessarily require a larger number of leases as the majority of the leases currently issued are not used to their full potential.

Low Growth Scenario

One possibility is for production to essentially remain at the same level through to the year 1995 and begin increasing at a relatively slow rate of say 5% between 1995 and the year 2000. Under this assumption, production will increase by about 400 MT to 3,000 MT by the year 1995, and to 4,000 MT by the year 2000. Under this scenario, employment will increase proportionally to about 100 full-time equivalent position by 1995 and to 130 by the year 2000.

Conditions which could restrict the growth of the industry are summarized below:

- Developing markets for the European oyster may prove more difficult than anticipated such that oyster prices may drop below or near production costs, thereby deterring investment.

- The hatchery in Nova Scotia may be setback by diseases, lack of financing or other factors which may limit the availability of seed to the industry.

- The Canadian dollar may increase in value relative to the United States dollar which could reduce the competitive position of domestic producers of American oysters for export relative to their counterparts in the United States.

- Adequate levels of financing, particularly from the private sector, are likely to be a problem due to the fact that the European and American oyster take a number of years to reach market size.

- Profitability in the industry may be such that the private sector finds it unattractive to invest in a crop which takes as much as six years to harvest.

Medium Growth Scenario

One alternative is for the oyster industry in Eastern Canada to reach a production of 4,000 MT by 1995 and 6,500 MT by the year 2000, which is about a mid point production level between the high and low growth scenarios. Under this assumption, employment will be around 135 full-time equivalent positions by 1995 and about 215 by the year 2000.

CONCLUSION

In conclusion, the oyster industry in Eastern Canada will likely see its production levels increasing to between 4,000 MT to 9,000 MT by the year 2000. A major constraint to growth will be adequate financing from private sector investment. The availability of oyster seed may also be a constraint if the new hatchery in Nova Scotia does not prove viable.

CHAPTER 5 - THE MUSSEL FARMING INDUSTRY

HISTORICAL DEVELOPMENT

Virtually all of the blue mussel supply in Canada is produced in the Atlantic region with a very limited supply coming from British Columbia. Mussel production in Atlantic Canada and B.C. is shown in Table 20. Estimates of historical mussel production for P.E.I. and Atlantic Canada vary widely depending on the source of information. The data presented in this chapter are based on statistics published by the P.E.I. government and the Department of Fisheries and Oceans.

In 1987, Prince Edward Island accounted for 70% of the total Canadian production of blue mussels, Nova Scotia accounted for about 17%, Newfoundland and Quebec shared the remaining 13% and New Brunswick and B.C. produced an insignificant amount. Virtually all mussel production in Canada is from cultivated stocks rather than wild stocks. Table 20 also shows that the industry in P.E.I. went from producing 12 MT in 1978 to producing in excess of 1,000 MT in 1987, an 85 fold increase.

Mussel production in P.E.I. is expected to increase again in 1988 reaching about 1,365 MT or about 31% more than in 1987. 1988 mussel production throughout Atlantic Canada is expected to exceed 2,000 MT. Production increased in 1988 despite a health alert on mussel cultivation after mussel related illnesses were reported. The health alert was lifted in some regions of Atlantic Canada within a few weeks following but it was not entirely lifted until February 1988 in P.E.I.

The poisoning and the resulting health alert was most detrimental to the Canadian market where the incident was advertised widely. According to producers in P.E.I. and in Atlantic Canada, markets have now recovered and 1988 production since the health alert has been higher than during the same period last year.

TABLE 20

PRODUCTION OF BLUE MUSSELS
(metric tonnes)

PRODUCTION IN P.E.I.

1978	12	1984	285
1979	14	1985	465
1980	49	1986	1,220
1981	47	1987	1,037
1982	70	1988*	1,365
1983	163		

1987 PRODUCTION BY PROVINCE
(metric tonnes)

Prince Edward Island	1,037	70%
Nova Scotia	257	17
Newfoundland	100	7
Quebec	80	6
New Brunswick	10	-
British Columbia	2	-
	1,486	100%

* - estimated

Notes:

1. Estimates of historical mussel production for P.E.I. and Atlantic Canada vary widely depending on the source of information. The data presented in this table are based on statistics published by the P.E.I. Government and the Department of Fisheries and Oceans.

Sources:

P.E.I. production of blue mussels: P.E.I. Department of Fisheries, 1988 estimate corresponds to about 3 million pounds.

1987 mussel production by province: Commercial Aquaculture in Canada, Department of Fisheries and Oceans, Ottawa, ISBN 0-662-16421-0 1988.

Neil Bourne,'Potential for Mollusc Culture in the Northeast Pacific', Aquaculture International Congress Proceedings, Vancouver, B.C., 1988.

Gerald Arsenault, A Broad Outlook on the Blue Mussel Supply Worldwide. Aquaculture International Congress Proceedings, Vancouver, B.C., 1988.

The data reported in table 20 represent actual shipments from the processing plants. Mussel production in the water may be higher because of inventories, and a certain portion of the landings at the plant being judged non-marketable. Estimates of the 1988 P.E.I. overall mussel production are as high as 2,200 MT (5 million pounds).

Worldwide production of blue mussels is estimated at 850,000 MT, which represents about 80-85% of the total world mussel catch of all mussel species. Major producing countries include France, the Netherlands, Spain, Denmark, and West Germany which together produce about half of the worldwide production. Other major producing countries include China, Thailand, and Korea.

The mussels produced in Canada are typically sold fresh. In that market, Canadian blue mussel producers compete primarily with the U.S. which in 1987 produced about 17,000 MT. The bulk of the production originated from New England with the Pacific Northwest producing around 100 MT in 1987. The operations in New England utilize bottom culture operations which produce an inferior semi-cultivated product. Poor quality in a mussel includes embedded pearls, low meat yield, discolored meat, and sand or silt in the body cavity.

In Eastern Canada, the blue mussel is cultivated using off-bottom techniques which result in a much higher quality product than the New England mussels. The culture process takes about 20 months and harvesting is typically done in the winter when the mussels and the markets are at their best. Harvesting is often done through the ice.

Mussel farms in Eastern Canada are very localized:

- In P.E.I., the mussel farms are located in the deeper estuaries along the East side of the Island and the North side from St-Peters Bay to Malpeque Bay.
- In Nova Scotia, the mussel farms are in Cape Breton and on the Eastern and Southern shores of the province.

- There are very few mussel farms in New Brunswick. The blue mussel cannot grow in the Bay of Fundy because of the toxic dinoflagellate which causes paralytic shellfish poisoning (PSP). There is some potential, however, for mussels to grow in the Gulf of St. Lawrence.

- In Quebec, mussel production is concentrated in the Isles-de-la-Madeleine and in the Baie des Chaleurs.

- In Newfoundland, mussel farms are located in the Northeast.

- In B.C., the blue mussel grows well throughout the province. However, commercial ventures have not proved feasible primarily because of:
  - severe diving duck predation;
  - unexplained pre-harvest mortalities in the winter; and
  - fouling by a variety of organisms including barnacles and tunicates which add to weight of the lines and require additional flotations.

The following section summarizes a number of factors which may restrict industry growth in Atlantic Canada and in B.C. over the next decade.

CONSTRAINTS

P.E.I. and Atlantic producers have been very successful in developing a market for the cultivated blue mussel. The mussel industry specializes in producing a premium product at a premium price. The present sales distribution of P.E.I. production is as follows:

TABLE 21

SALES DISTRIBUTION OF P.E.I. MUSSELS

Quebec	48%
Ontario	18%
California	14%
Maritimes	8%
Western Canada	5%
Florida	1%
Other	6%

Source:

Gerald Arsenault, A Broad Outlook on the Blue Mussel Supply Worldwide. Aquaculture International Congress Proceedings, Vancouver, B.C., 1988.

The Atlantic blue mussel industry competes in the Canadian and U.S. markets against the semi-cultivated mussel produced in the U.S. About 65% of the Canadian mussel consumption is supplied by the U.S. wild and semi-cultivated mussel. The Canadian cultured mussel has superior quality over the semi-cultivated U.S. product but the price is higher. An important part of ensuring markets for the Canadian blue mussels therefore relies in promoting and convincing consumers of the superiority of the cultivated product. To date, some promotion has been conducted by the P.E.I. Development Agency.

The market potential for blue mussels is difficult to assess because of its dependence on promotion and advertising. A recent DFO market study estimates that the supply of mussels will exceed demand as early as 1990. If this occurs, marketing constraints will seriously restrict the growth of the industry.

Other constraints which may limit the growth of the mussel industry in Eastern Canada are as follows:

- **Site availability**. Most of the leases available in P.E.I. have been allocated. However, there are a number of other sites in Atlantic Canada that are suitable for mussel production.

- **Government regulations**. Regulations in P.E.I. have fostered the growth in the industry. A prospective grower can get a Conditional Permit which will allow him to farm a chosen site for two years before he has to negotiate surveys and pay for his lease. The provincial government has also implemented programs to assist growers during start-up and for expanding facilities. In the other provinces, and particularly in Nova Scotia, the industry has complained about delays in the leasing and permit process.

- **Production**. There is some concern that the industry in P.E.I. has been exceeding the carrying capacity of the estuaries and that this may ultimately affect seed supply, food abundance and the survival rate of the mussels. This will not be a concern in the other provinces for sometime to come.

- **Growth cycle**. The growth cycle of 18 to 24 months for mussels is a constraint to industry growth particularly as it relates to financing during the start up years.

- **Pollution and contamination.** The industry faces the risk of contamination, and the resulting fishery closure. The incident of December 1987 is only one example of this. In attempting to guard against this, the industry and governments are always improving on tests and safeguards.

- **Production costs and profitability.** The production of cultivated mussels is a relatively costly labour intensive process. Transportation costs are also fairly high ranging around 20% of the delivered costs to Montreal and Toronto. Mussels sell for approximately $2.20 per kilo, which according to industry sources is not significant when the production, transportation, and marketing costs are taken into account.

In B.C., the problems faced by mussel growers are production rather than market oriented. As described in a paper by Neil Bourne of the Pacific Biological Station, in B.C., which is titled 'Potential for Mollusc Culture in the Northeast Pacific', the major problems facing mussel culture in B.C. include:

- **Fouling by a variety of organisms including barnacles and tunicates.** These add to the weight of the lines, require additional floatation and cause processing difficulties.

- **Duck predation.** B.C. is a wintering area for several species of ducks. Duck predation can be controlled by maintaining nets around growing lines but this adds to costs. Scaring ducks through discharging guns is usually not allowed because of pressures from local residents.

- **Unexplained summer mortality rates as high as 80%.** Studies indicate that the mortalities are probably due to physiological stress rather than disease as there appears to be a genetic component to the growth and survival of different strains of mussels. Further studies are required to determine the cause of this high mortality rate and to potentially solve this problem.

STRENGTHS

Some of the strengths of the industry in Atlantic Canada as well as in B.C. are as follows:

- **Seed supply.** A major advantage in mussel culture is the abundance of natural seed which can be gathered by using collectors or simply scraping mussel seed from rock walls at low tide.

- **High quality product.** The cultivated mussel is a higher quality product than the wild and semi-cultivated mussel. This provides an opportunity to displace Canadian imports of wild and semi-cultivated mussels.

- **Untapped markets.** Up until now, the industry has made little effort to expand the Canadian and U.S. market for what is essentially a new product.

OUTLOOK FOR THE INDUSTRY

This section projects to the year 2000, the size of the mussel industry in Eastern Canada as well as in B.C. The projections under high, medium and low growth assumptions are presented in the table below and in the paragraphs following.

TABLE 22

OUTLOOK TO THE YEAR 2000
MUSSEL INDUSTRY

	Production		Full-time Equivalent positions	
	1995	2000	1995	2000
	(metric tonnes)			
British Columbia:				
High growth	100	1,000	10	70
Medium growth	50	300	10	20
Low growth	10	50	5	10
Atlantic Canada:				
High growth	5,000	7,000	330	450
Medium growth	4,250	5,500	280	350
Low growth	3,500	4,000	230	250

High growth

Over the next decade, the potential for the mussel industry in Atlantic Canada to continue to grow will depend on the industry's ability to

develop markets and maintain prices at or above current levels. Even if the number of sites in P.E.I. and the production capacity of that province prove to be limited, there are enough sites in the other Atlantic provinces to allow the industry to develop provided that markets exist.

One possibility is for industry production in Atlantic Canada to increase from about 1,500 MT in 1987 and an estimated 2,000 MT in 1988 to about 5,000 MT in 1995 and 7,500 MT by the year 2000. This translates to an annual compounded rate of about 14% between 1988 and 1995 and about 8% between 1995 and the year 2000. Expressed in percentage terms this rate is only a fraction of the 65% annual compounded rate experienced in P.E.I. between 1978 and 1987 when the production increased more than 85 times.

In terms of absolute production figures, however, the assumed growth is fairly optimistic. The industry in Atlantic Canada achieved shipments of 1,500 MT in about ten years of production or an increase of about 150 MT per year. This high growth scenario estimates that the industry will increase production by about 400 MT per year or about 3,000 MT by 1995 and by a further 2,000 MT, five years later.

The achievement of this production level will require that:

- Prices remain around existing levels. The industry must expand demand in order to increase the supply of mussels.
- Production costs remain stable.
- Government regulations and programs similar to those in effect in P.E.I. are developed in New Brunswick, Nova Scotia, and Newfoundland in order to encourage new entrants in the industry. (In Quebec the number of available sites rather than government regulations is likely to be restricting the growth of the industry).
- The mussel industry does not experience a major disease or contamination.

The Mussel Growers Association in P.E.I. estimates that the industry provides between 100 and 300 jobs depending on the season. Employment in the industry in that province is estimated to be about 100 full-time equivalent positions. This is based on the following assumptions:

- A labour cost component of about 40% of the wholesale value of production at the processing plant.
- A wholesale price of about $1.00 per pound or $2.2/kg.
- An average labour cost of $8.00 per hour.
- An average number of 1,500 hours worked per full-time equivalent position (or about 30 hours per week for 50 weeks).

This translates to about 15 MT per full-time equivalent position. On this basis, a production level of 5,000 MT by 1995 will translate to about 330 full-time equivalent positions throughout the Atlantic provinces. By the year 2000, employment in the industry will increase to over 450 full-time equivalent position, provided that a production level of 7,000 MT is achieved.

Estimating the number of sites and growers required to meet this production level is difficult given the high number of leases that are currently under-utilized.

The situation in B.C. is quite different than in Eastern Canada. The major constraint to the industry in B.C. is the summer mortality problem. A high growth scenario for the industry in B.C. assumes that this problem will be solved within the next five years, thereby giving the chance for commercial operations to be established by the year 1995.

One possibility under this assumption is that the industry could produce 100 MT by the year 1995. After that time, the industry could be expected to duplicate the growth experienced in the five years between 1983 and 1988 in P.E.I. when mussel shipments increased from about 163 MT in 1983 to 1,365 MT in 1988. On that basis, B.C. will potentially reach 1,000 MT in mussel production by the year 2000. Other factors which will have to materialize for this to happen include:

- B.C. develops a local and U.S. market for blue mussels.
- B.C. succeeds in competing with P.E.I. and the Atlantic provinces in the cost of mussel production. For this to happen, the cost of

dealing with fouling and duck predation will have to be lower than the transportation cost between Eastern Canada and the markets to be served by B.C. producers. Also, labour and other costs will have to be lower or equal to those in the Atlantic provinces.

. Government regulations and programs in B.C. will have to be at least as favourable to the mussel industry as they have been in P.E.I.

Low growth

One possibility is for the Canadian mussel industry to grow fairly slowly over the next ten years, with production increasing from an estimated 2,000 MT in 1988 to 3,500 MT by 1995 and to 4,000 MT by the year 2000:

. The industry in P.E.I. may plateau in terms of production at about 3,000 MT. Shipments are 1,365 MT in 1988, but estimates for mussel production 'in the water' are as high as 2,200 MT for 1988 (5 million pounds) and 3,600 MT for 1989 (8 million pounds). Production may plateau in P.E.I. because of site restrictions, biological and/or other problems.

. The industry in Quebec may increase fairly slowly given that mussels grow only in the Isles-de-la-Madeleine and the Baie des Chaleurs.

. Increases in mussel production in New Brunswick, Nova Scotia and Newfoundland may not materialize:
  - The industry in these provinces may not receive sufficient government attention in terms of favourable regulations and government programs.
  - The profitability of the industry may be reduced through lower prices or increased production costs, thereby limiting new investment in the industry.
  - Sites in these provinces may not prove to be as suitable to mussel production as is currently anticipated.

. Mussel growers in B.C. may continue to be plagued with heavy summer mortality rates, fouling by barnacles and tunicates as well as duck predation, such that commercial production remains uneconomical.

Under this scenario, employment will also increase more slowly, perhaps reaching 250 full-time equivalent positions in Atlantic Canada and 10 in B.C. by the year 2000.

Medium growth

One possibility is for the Canadian mussel industry to reach a production of 4,300 MT by 1995 and 5,800 MT by the year 2000, which is about the mid point between the high and low growth scenario. Under this assumption, employment in Eastern Canada will be around 280 full-time equivalent positions by 1995 and about 350 by the year 2000, based on about 15 MT per full-time equivalent job. Employment in B.C. will range between 10 and 20 full-time equivalent positions.

CONCLUSION

In conclusion, the mussel industry is well established in P.E.I. and in the Atlantic provinces. Production in these provinces is expected to be between 4,000 and 7,000 MT by the year 2000. In B.C. the future of the industry will depend on the ability of the industry to control heavy summer mortality rates and deal with predators and other production problems. Depending on the industry's ability to control these problems, the mussel industry in B.C. will either remain at an infancy stage, and produce about 50 MT by the year 2000, or it will become a viable industry which could produce as much as 1,000 MT by the year 2000.

CHAPTER 6 - THE TROUT FARMING INDUSTRY

HISTORICAL DEVELOPMENT

Trout farming in Canada started more than 100 years ago primarily in the form of freshwater hatcheries established by governments and the private sector for resource enhancement purposes. The production and sale of trout for human consumption started on a commercial basis about 25 years ago in Ontario and it has made inroads in all provinces to varying degrees since that time. Trout farming in Canada has been primarily in fresh water but with the growth of marine culture, the industry has been rearing marine trout in sea cages, primarily in Nova Scotia.

Rainbow trout is the primary species of fish raised on Canadian freshwater fish farms. It has been bred and reared for many decades and is now a domesticated fish with a rapid rate of growth, high resistance to disease, and a good tolerance to crowding.

The production of trout in Canada serves three major markets:

- Pond fishing - which in Quebec alone accounts for about 60% of the total trout production.
- Lake and river stocking.
- Human food consumption.

This chapter focuses on the production and potential for trout farming for the food market. In that market, Ontario is the leading Canadian freshwater trout producer with a production of rainbow trout totalling about 1,500 MT in 1987 and 1,800 in 1988. Together, the other provinces produced less than 500 MT of freshwater rainbow trout, although Nova Scotia produced about 215 MT of marine rainbow trout, and B.C. about 100 MT. Trout production in Canada is presented in table 23.

TABLE 23

PRODUCTION OF RAINBOW TROUT FOR THE FOOD MARKET

A. HISTORICAL PRODUCTION OF FRESHWATER TROUT

	B.C.	Ontario	Quebec	Atlantic Canada
1970	n/a	91	n/a	n/a
1975	n/a	136	n/a	n/a
1977	58	n/a	n/a	n/a
1978	54	n/a	n/a	n/a
1979	53	n/a	n/a	n/a
1980	56	408	n/a	83
1981	71	454	n/a	86
1982	74	540	n/a	105
1983	77	499	n/a	148
1984	71	499	n/a	109
1985	83	544	n/a	96
1986	101	1,134	n/a	111
1987	115	1,451	130	330*
1988	n/a	1,814*	250*	n/a

B. 1987 ESTIMATED FRESHWATER AND MARINE TROUT PRODUCTION IN CANADA

Ontario	1,451
Quebec	130
B.C.(1)	215
Saskatchewan	69
New Brunswick	41*
Nova Scotia(2)	250
Manitoba	40
Newfoundland	10*
P.E.I.	19*
Alberta	n/a
	2,225

* - estimated
n/a - not available

Notes:

1. Includes about 100 MT marine trout production.

2. Includes 215 MT of marine trout produced in Nova Scotia and smaller volumes of marine trout production from other Atlantic provinces.

Source:

B.C.: Commercial Aquaculture in Canada, Department of Fisheries and Oceans, 1988

Ontario: Moccia, R.D., Aquaculture Extension Centre, University of Guelph, Unpublished information.

Blum H. 1979, Fish Farming in Ontario - an industry study, Ontario Ministry of Agriculture and Food.

Quebec: discussion with industry sources.

Atlantic Canada: Aiken, D.E., Status of Aquaculture in Atlantic Canada, Aquaculture Association of Canada Bulletin, Edition 87-1.

The production of trout in Ontario has grown from about 100 MT in the early 1970's to about 500 MT by 1985 and 1,800 MT by 1988. Since 1985, the industry in Ontario has averaged an annual rate of growth of about 50%. The growth in production has been more stable in B.C., averaging about 7% a year over the last 10 years and about 17% between 1984 and 1987. Trout production for human consumption in Quebec has doubled in the last year and it is now about 250 MT. In Atlantic Canada and in Newfoundland, the production of freshwater trout is about 100 MT overall although marine trout production exceeds 200 MT.

Trout farming in the prairies is fairly limited relative to the other provinces. The industry in Alberta, Saskatchewan and Manitoba is dominated by hobby farms and private fish growers who purchase fingerlings (fish between 5 and 10 cm in length) and raise them in private ponds through the summer months. The number of growers interested in rearing trout for human consumption is increasing, however, with one grow out site in Manitoba accounting for the majority of the province's production.

Trout farming in the Territories is currently restricted to lake enhancement purposes. There is a growing interest in rearing trout for human consumption but no actual production.

FRESHWATER TROUT PRODUCTION IN OTHER COUNTRIES

World production of freshwater rainbow trout in 1986 was 127,000 MT with the five major producing countries being Italy (33,000 MT), Denmark (20,000 MT), the United States (18,000 MT), Rumania (16,000 MT), and Japan (15,000 MT).

Approximately 80-85% of the U.S. trout production is concentrated in Idaho. This province has an exceptional supply of fresh water from what is referred to as the 'Snake River Plains Aquifer'. One of the largest farms in Idaho produces about 700 MT of freshwater trout each year. Being on the banks of the Snake river, it benefits from underground lakes which form each year from the area's snow and rain precipitation (the water eventually surfaces to form springs that pour through fissures of the rock).

CONSTRAINTS

There are a number of constraints facing the trout farming industry in Canada. These are reviewed in a number of areas, namely:

- Site availability;
- Financing;
- Markets;
- Feed costs;
- Production;
- Production costs and profitability; and
- Government regulations;

Site Availability

The availability of sites for freshwater trout depends on a number of factors including:

- Availability of fresh water sources.

- Adequate flushing.
- Water temperatures.
- Proximity to markets.

The availability of fresh and high quality water may be a limiting factor for freshwater trout production depending on the region.

Natural and artificial ponds, although suitable for sport fishing are not suitable for commercial operations. Disadvantages include:

- Low water turnover and resulting degradation of the environment;
- The potential for diseases due to inadequate flushing;
- Fluctuations in temperature; and
- Difficulty in harvesting because of different sizes and lack of uniformity in the fish produced.

The production of trout in cages situated on lakes and other surface water is not considered feasible. Most lakes in Canada are too cold and covered with ice in the winter and too warm in the summer to be suitable to grow freshwater trout on a commercial basis. The use of surface water for fish farming also creates problems with other resource users, such as recreation and tourism. The spreading of diseases from wild fish to the cultured fish and vice versa also needs to be considered.

Because of the difficulties in growing trout in ponds or in cages situated in lakes, fish farms typically raise rainbow trout in circular fish tanks and rectangular raceways. The fish tanks resemble large circular swimming pools. Raceways are large rectangular units where water flows through quickly, entering at one end and exiting at the other. Through the use of screens, raceways allow fish to be segregated by size.

The use of raceways and fish tanks both require substantial amounts of water, although the water requirement is less for fish tanks than for raceways. The quantity of water (volume per unit time) available

generally restricts farm capacity. Water quality and temperature are also important factors. Polluted water typically encourages diseases. Also, although water temperature in fish tanks may be controlled, the cost of artificially heating or cooling the volumes of water required to operate a facility may be prohibitive.

The majority of commercial freshwater trout farms in Canada operate using groundwater rather than surface water. Groundwater (water taken from the head of springs, artesian wells or pumped from underground) is often better suited for trout production than surface water. Accordingly, many of the farms in Ontario, are located in south central and southwestern Ontario with many located on the Niagara escarpment where fairly large volumes of groundwater can be found. Although the majority of trout farms in Ontario use groundwater, there is increasing interest from fish farmers in Ontario in pumping fresh water from the Great Lakes into fish tanks and raising fresh water trout.

Although the choice of site is important in determining the profitability of an operation, site availability is not likely to be a major constraint to growth in most parts of Canada:

- In Ontario, there are still untapped sources of groundwater and many of the existing sites could produce more if warranted by markets. There is also substantial potential for increasing production at farms planning to utilize Great Lakes water.

- In Quebec, the Abitibi area in the northwestern region has significant amounts of untapped groundwater, giving this region substantial potential for trout production.

- In Atlantic Canada, groundwater is in short supply, particularly in Newfoundland and in P.E.I. In all these provinces, however, there is potential for pumping ocean water and producing marine trout in land based systems.

- Trout production for food consumption is at a developmental stage in the prairies. From a biological standpoint, trout farming production is not limited by the availability of sites.

. In B.C., the majority of trout farms are located in the Lower Mainland on private lands, but there are other sources of groundwater in other regions.

Financing

The growth cycle of freshwater trout is about two years. Accordingly, cash flow is a problem during the start-up years. In addition, financial institutions are typically reluctant to finance trout farming operations because of the risks involved.

Markets

In 1987, Canada imported 1,062 MT of trout including 252 MT of fresh trout, 540 MT of frozen trout and another 270 MT of other trout products, as demonstrated in table 24.

TABLE 24

IMPORTS OF RAINBOW TROUT IN CANADA
(metric tonnes)

	Trout Imports (Canada)				Trout Imports by Province			
	Fresh	Frozen	Other Products	All Kinds	Ontario	Que	B.C.	Other Provinces
1981	227	586	384	1,197	n/a	n/a	210	n/a
1982	171	595	63	829	n/a	n/a	112	n/a
1983	159	543	57	759	n/a	n/a	97	n/a
1984	170	567	242	979	628	154	120	77
1985	236	206	409	851	548	79	146	78
1986	296	313	416	1,025	647	113	156	109
1987	252	540	270	1,062	602	150	192	118

n/a: not available

Source: Statistics Canada

Table 24 also shows that imports have remained at around 1,000 MT since 1981, despite the growth in trout production in Canada of over 1,000 MT during that same period. This is largely because the Canadian products do not compete directly with the imported products. Canadian trout are sold

fresh with increasing amounts being sold smoked or as filets rather than pan sized. The majority of imported trout from Idaho are sold frozen, at an average weight of about 250 g and for a lower price than the Canadian product.

Because the Canadian product has the potential to be sold fresh all year round, the potential to displace imports is not indicative of the size of the total market. Moreover, as is the case for other fish products, there has been little advertising and promotion directed at the consumer market.

Although the market for freshwater trout in Canada has the potential to expand, it does need to be developed. Accordingly, there are likely to be some limitations regarding market growth in the future.

Opportunities for export are likely to be limited except perhaps to the U.S. Northeast. However, there is likely to be increased competition from states like Montana which are starting to look at trout growing with interest.

Feed Costs

The cost of feed in rearing rainbow trout is significant. In Ontario, the cost of feed is estimated to represent between 40 and 70% of the cost of producing the fish. The situation is similar in other provinces.

Production

Rainbow and other freshwater trout are susceptible to diseases including Bacterial Kidney Diseases (BKD). Various vaccines and disease treatments are available to the industry.

Production Costs and Profitability

Trout farming yields modest returns which are comparable to those earned in other agricultural ventures. The risks associated with trout farming are somewhat larger and the modest returns may limit investment and thus industry growth in the future.

There have been a number of studies in Quebec and in Ontario which have investigated the viability of growing freshwater trout:

- In Ontario, a review conducted by the provincial government suggested that 'the return to trout farming was modest in view of the investment costs and risks associated with trout production in Ontario'. In that report, the average revenue per kg of fish produced for a 22,700 kg operation (50,000 pounds) was estimated at $5.13 per kg. This compared with variable and fixed expenses of $4.31 per kg before considering the salary level of the owner operator but after interest expenses assuming 70% debt. This model farm was intended to be of sufficient size to allow the owner operator to obtain his livelihood from the farm which was estimated at $18,500 a year.

- A recent study of trout fish farming in Quebec indicated that the industry is less profitable in Quebec than in Ontario. According to that study, trout farmers in Quebec earn, before taxes, an average net return on equity of 9.8% and a return on assets of 5.8%. The survey also determined that the most profitable operations were those oriented towards the growing of fingerlings and hatcheries rather than the grow out farms. The study pointed out that these returns could be considered to be minimum values. Nevertheless, the results showed that trout farming seemed less profitable than other agricultural ventures.[3]

Although these studies indicate that trout farming does not yield very attractive returns, the feasibility of trout farming is very site specific such that any study of average returns is not really meaningful. Moreover, trout farming is often combined with other agricultural ventures like tobacco growing, which can make it more attractive.

Government Regulations

Trout farming in Canada is regulated primarily to protect the environment and in some cases the integrity of the wild stocks. In Quebec, only rainbow trout may be legally sold for human consumption. This is expected to change as early as April 1989 thereby allowing brook trout to be grown for food consumption.

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[3]Aquiculture en eau douce au Quebec: quelques resultats financiers, M. Letourneau, J.C. Michaud, et C. Bedard, Aquaculture Association of Canada, Proceedings, Quebec, 1987.

STRENGTHS

The trout farming industry in Canada is not as well established as in the U.S. (particularly in the State of Idaho) and other countries. Some of the advantages of Canadian trout producers are outlined below:

- **Proximity to markets.** The industry in Canada can expand to serve the domestic market. However, limited opportunity exists for exporting trout products, with the exception of the U.S. northeast.

- **Expertise and Infrastructure.** This is particularly true in Ontario, where trout farming has been an established industry for at least ten years. In other provinces, like B.C., Quebec and the Atlantic provinces, the growth of salmon aquaculture has resulted in the knowledge and expertise related to fish farming being improved significantly.

- **Availability of fingerlings.** Trout farming has been an established industry in all provinces for resource enhancement purposes and for lake and river stocking. Accordingly, there are hatcheries and fingerling producers in all provinces except in certain regions of Atlantic Canada. These hatcheries can supply smolts and fingerlings to the growing trout farming industry.

- **High quality product.** The Canadian product is of high quality and it commands a higher price than the imported trout from Idaho and other parts of the U.S. This allows Canadian producers to compete against Idaho producers who have lower production costs because of the extensive supply of groundwater. Idaho operations are also very capital intensive and they rely on advanced technology.

OUTLOOK FOR THE INDUSTRY

The production and employment projections under high, medium, and low industry growth assumptions are presented in tables 25 and 26 and are described in the paragraphs following.

TABLE 25

TROUT PRODUCTION OUTLOOK TO THE YEAR 2000

	Low Growth		Medium Growth		High Growth	
	1995	2000	1995	2000	1995	2000
Freshwater Trout						
Ontario	2,000	2,400	2,800	3,500	3,500	4,500
Quebec	500	600	700	1,000	1,000	1,500
B.C.	100	200	200	400	300	600
Atlantic Provinces	100	200	150	250	200	300
Prairies	100	100	150	250	200	400
	2,800	3,500	4,000	5,400	5,200	7,300
Marine Trout (1)						
B.C.	250	500	600	1,250	1,000	2,000
Atlantic Provinces	250	500	600	1,250	1,000	2,000
	500	1,000	1,200	2,500	2,000	4,000

Note:

1. Production may be higher if trout farming is substituted for salmon farming.

TABLE 26

TROUT FARMING EMPLOYMENT PROJECTIONS

TO THE YEAR 2000

	Low Growth		Medium Growth		High Growth	
	1995	2000	1995	2000	1995	2000
Freshwater Trout (1)						
Ontario	165	200	230	290	290	375
Quebec	40	50	60	85	80	125
B.C.	10	15	15	30	25	50
Atlantic Provinces	10	15	10	20	15	25
Prairies	10	10	10	20	15	30
	235	290	325	445	425	605
Marine Trout (2)						
B.C.	10	20	20	45	35	75
Atlantic Provinces	10	20	20	45	35	75
	20	40	40	90	70	150

Notes:

1. Based on 12 MT of fresh trout production per man year.

2. Based on 27 MT of marine trout production per man year, which is based on salmon production employment in New Brunswick (production capability of 10,000 MT translating to 375 person years or about 27 MT capacity per person year).

High Growth Scenario

In Canada, trout farming is a more mature industry than the culture of other fish and mollusc. Accordingly, in comparison to the culture of salmon, oysters and mussels, the potential for growth is more modest although still significant.

One of the most serious limitations for the growth of the industry is its relatively modest profitability. Because of the competition from the State of Idaho and other producers, there is limited potential for prices to increase. Prices for freshwater trout may even face demand pressures with the increasing supply of farmed salmon and other seafood products.

One possibility for a high growth scenario is for Canadian producers to displace imports of freshwater trout and succeed in increasing demand for freshwater trout. Under this scenario, Canadian producers will potentially produce as much as 5,200 MT of freshwater trout by 1995 and 7,300 MT by the year 2000.

The production of marine rainbow trout is also expected to increase in Atlantic Canada and B.C. One possibility is for the Canadian production to increase to 2,000 MT by 1995 and to 4,000 MT by the year 2000. This assumes that salmon farming continues to be more popular than trout farming.

Under this scenario, employment in the freshwater trout farming industry will be equivalent to 425 full-time jobs by 1995 and 605 by the year 2000, based on a production of 12 MT per full-time job. This production level was calculated based on statistics available for the Ontario industry as described below:

- A labour cost component of $1.00 per kilo of freshwater trout, based on cost data reported in 'Aquaculture in Ontario', a publication of the Ontario Ministry of Natural Resources.
- An average labour cost of $8.00 per hour and an average of 1,500 hours worked annually per full-time equivalent position.

Employment resulting from the increased production of marine trout under high growth assumptions is estimated at 70 full-time equivalent jobs by 1995 and 150 by the year 2000. This is based on an average production level of 27 MT per person year, which is comparable to the employment impact of salmon farming in B.C. and Eastern Canada. The growing of marine trout is assumed to be less labour intensive on a per tonne basis

than freshwater trout, primarily because the freshwater trout farms are usually less capital intensive than the salmon and marine trout farms.

The next paragraphs review the potential for trout farming by province.

Ontario:

The industry in Ontario has grown from producing about 100 MT in 1970 to producing about 500 MT in 1985 and 1,800 in 1988. This growth in production translates to a rate of 17% a year over the whole period but about 50% over the last three years. Production was stagnant between 1981 to 1985, probably reflecting the high interest rates prevailing in that period and the poor economic climate.

One possibility under high growth assumptions is for the industry in Ontario to double production to about 3,500 by 1995, which represents about a 10% a year increase and an annual production increase of 250 MT per year. Assuming the industry continues to increase production by about 250 MT per year through to the year 2000, the Ontario production will reach about 4,500 MT by the year 2000.

The achievement of this production level will require the following:

- The industry in Ontario succeeds in expanding the domestic market for fresh trout. The increase in production of 2,700 MT by the year 2000 represents an increase of about 300 grams of trout per capita, based on a population of eight million people in Ontario. This is a sizeable increase which will undoubtedly require extensive promotion to entice consumers in Ontario to increase their demand for fish and/or substitute trout for other fish. The challenge will be for producers to incur the costs associated with promotion and still continue to operate profitably.

- The interest rate and economic conditions remain favourable to investments in the industry. Trout farming in Ontario is often combined with other agricultural ventures such that the economic well-being of the agricultural community in Ontario could impact on the level of investment into trout farming. Also, increases in borrowing costs make financing an even more important constraint to growth. Financing is already difficult because of the growth cycle of trout being between one and two years, which is longer than the average agricultural crop.

- The industry succeeds in maintaining labour, feed and other operating costs. The industry yields a relatively modest rate of return and it may not be able to bear any increase in feed or other costs.

- The industry continues to control diseases successfully.

Quebec:

The ability of Quebec to increase the production of freshwater trout will also depend on interest rates, overall economic conditions, the cost of production, and markets. Trout production for the food market in Quebec has increased from 130 MT in 1987 to about 250 MT in 1988. The provincial government has instituted a government program to encourage trout production and the objective is to increase trout production to 1000 MT over the next five years.

One high growth scenario is that Quebec reaches this ambitious objective by 1995. Production will then be expected to grow by say 100 MT through to the year 2000, reaching an overall production level of 1,500 MT.

British Columbia:

The industry in B.C. can also be expected to grow over the next decade, albeit at a slower rate. Over the last ten years, the production of freshwater trout in B.C. has grown at a rate of 7% a year. Under optimistic assumptions, the industry will grow at double that rate or about 15 % a year. This translates to a production of 300 MT by 1995 and about 600 MT by the year 2000.

This production level excludes any production of marine trout. With the recent growth in farmed salmon production in B.C., some of the farms and particularly the land based systems may decide to rear rainbow trout rather than salmon. Rainbow trout can be reared at a much lower cost than salmon and could become more attractive economically if salmon prices decline substantially in the near future.

Atlantic Canada:

The production of rainbow trout in Atlantic Canada may also increase, particularly with the increasing interest in rearing marine trout. In Nova Scotia, there are already 37 farms that are rearing rainbow trout in sea cages and production has increased to about 215 MT in 1987. The overall production for marine and rainbow trout in Atlantic Canada is estimated at about 375 MT in 1988, with freshwater trout accounting for about 125 MT of this production.

One possibility is for the freshwater trout production to increase to 200 MT by 1995 and to 300 MT by the year 2000 but for marine trout production to increase to 1,000 MT by 1995 and 2,000 MT by 2000. The production of marine trout is more likely to increase than the freshwater trout production because of the lack of fresh water in P.E.I. and Newfoundland and the unlimited supply of sea water.

Prairies and Territories:

In the prairies and the territories, trout farming is at a development stage. Accordingly, under an optimistic scenario, these provinces may produce about 200 MT by 1995 and about 400 MT by the year 2000.

Low Growth

One possibility is for the industry to grow at relatively slow rate. Under this scenario, the Canadian production of freshwater trout may be as low as 2,800 MT by 1995 and 3,500 MT by the year 2000. This assumes the following:

- Interest rates increase and economic conditions worsen, such as to discourage new investments in the industry.
- The industry fails to develop new markets. This may be partly as a result of increased competition from other species like salmon, mussels, oysters and other shellfish.
- Feed and other costs increase while prices remain at the same level because of increased competition from other fish.

Under low growth assumptions, the industry will create about 235 full-time equivalent position by 1995 and about 290 by the year 2000. This is based on 12 MT per full-time equivalent position as was assumed in the high growth scenario.

As regards the production of marine trout, production under low growth assumptions may be as low as about 500 MT by 1995 and 1,000 MT by the year 2000. Under this scenario, the production of marine trout will increase slowly primarily because of unfavourable market conditions.

Medium Growth

Under medium growth assumptions, the industry may produce 4,000 MT of freshwater trout and 1,200 MT of marine trout by 1995. By the year 2000, the industry may produce 5,400 MT of freshwater trout and 2,500 MT of marine trout. This represents a mid point between the low and the high growth scenario.

Under this scenario, employment in the freshwater and marine trout industry will be around 365 full-time equivalent positions by 1995 and 535 by the year 2000.

CONCLUSION

In conclusion, the trout farming industry is not new to Canada but it continues to offer some significant potential for growth. A key challenge facing the freshwater and marine trout industries will be to develop markets in an environment which will become increasingly competitive. The ability to maintain costs will also be a challenge as the industry, and particularly the freshwater trout farming sector, is yielding only modest returns to the owner operators and investors. Throughout Canada, trout farming presents an alternate source of income to traditional farming and it is likely to continue to grow over the next decade.

SUMMARY AND CONCLUSIONS

In conclusion, the aquaculture industry in Canada is young and dynamic and the potential for growth is substantial. This chapter summarizes the production and employment projections of the major sectors of the industry and presents the combined employment impacts projected for the industry. A summary of the production and employment projections for salmon, oysters, mussels, marine trout and freshwater trout are presented in table 27.

TABLE 27

SUMMARY OF PRODUCTION AND EMPLOYMENT PROJECTIONS

	Production (metric tonnes)			Employment (full-time equivalent positions)		
	1988	1995	2000	1988	1995	2000
Salmon						
B.C.	4,500	20,000-30,000	25,000-50,000	750	950-1,500	1,050-2,400
Eastern Canada	3,250	4,600-11,000	6,000-16,000	170	305- 500	215- 625
Total	7,750	24,600-41,000	31,000-66,000	920	1,155-2,000	1,265-3,025
Oysters						
B.C.	3,100	4,000- 7,000	5,500-13,000	100	130-250	180-430
Eastern Canada	2,600	3,000- 5,000	4,000- 9,000	85	100-165	130-300
Total	5,700	7,000-12,000	9,500-22,000	195	230-395	310-730
Mussels						
B.C.	-	10- 100	50-1,000	-	5- 10	10- 70
Eastern Canada	2,000	3,500-5,000	4,000-7,000	135	230-330	250-450
Total	2,000	3,510-5,100	4,050-8,000	135	235-340	260-520
Marine Trout						
B.C.	100	250-1,000	500-2,000	5	10-35	20- 75
Eastern Canada	250	250-1,000	500-2,000	10	10-35	20- 75
Total	350	500-2,000	1,000-4,000	15	20-70	40-150
Freshwater Trout						
B.C.	125	100- 300	200- 600	10	10- 25	15- 50
Atlantic Canada	125	100- 200	200- 300	10	10- 15	15- 25
Ontario	1,814	2,000-3,500	2,400-4,500	150	165-290	200-375
Quebec	250	500-1,000	600-1,500	20	40- 80	50-125
Prairies & Territories	100	100- 200	100- 400	10	10- 15	10- 30
Total	2,414	2,800-5,200	3,500-7,300	200	235-425	290-605

TABLE 27
cont.

	Employment (full-time equivalent positions)		
	1988	1995	2000
Combined Impacts			
B.C.	865	1,105-1,800	1,275-3,025
Atlantic Canada	410	555-1,045	630-1,475
Ontario	150	165- 290	200- 375
Quebec	20	40- 80	50- 125
Prairies & Territories	10	10- 15	10- 30
Total	1,455	1,875-3,230	2,165-5,030

SALMON FARMING INDUSTRY IN B.C.

. Salmon farming is gaining importance in B.C. with production in 1988 being estimated at 4,500 MT. The industry is likely to produce between 20,000 MT and 30,000 MT by 1995 and between 25,000 and 50,000 by the year 2000. The B.C. production is unlikely to match the existing Norwegian production of 80,000 MT by the year 2000 because of increasing competition from other countries and marketing constraints.

SALMON FARMING INDUSTRY IN EASTERN CANADA

. Salmon farming is also gaining in importance in Eastern Canada. In that region, salmon farming is concentrated in the Bay of Fundy in New Brunswick but the industry is gaining in importance in Nova Scotia and to a lesser extent in Quebec and P.E.I. through the use of land based systems. Salmon farming in Newfoundland is at an experimental stage. Farmed salmon production in Eastern Canada in 1988 is estimated at 3,250 MT. The Eastern provinces are projected to produce between 4,600 and 11,000 MT by 1995 and 6,000 MT and 16,000 MT by the year 2000.

. These production estimates assume that the current technology of net pens operating in sea water will continue to be the most prevalent technology used in salmon farming. Technological changes and the widespread adoption of land based and other systems could result in even higher projected growth. Land based systems are technically feasible but their commercial viability has yet to be established.

OYSTER INDUSTRY IN B.C.

. 1988 oyster production in B.C. is estimated at 3,000 MT. The industry is projected to produce between 4,000 MT and 7,000 MT by 1995 and between 5,500 and 13,000 MT by the year 2000. Major constraints which will restrict the growth of the industry include the cost and availability of seed from hatcheries, financing and markets.

OYSTER INDUSTRY IN EASTERN CANADA

. Oyster production in Eastern Canada is estimated at 2,600 MT and because of water temperatures and other conditions is restricted to New Brunswick, Nova Scotia and P.E.I. Oyster production in Eastern Canada is projected to increase to between 3,000 MT and 5,000 MT by 1995 and between 4,000 MT and 9,000 MT by the year 2000.

MUSSEL INDUSTRY

. Mussel production in Canada is expected to exceed 2000 MT in 1988 with P.E.I. accounting for about three quarters of the overall production. This is based on data published by the P.E.I. government and the Department of Fisheries and Oceans; estimates of historical mussel production vary widely between sources of data. Industry production in Eastern Canada is expected to range between 3,500 MT and 5,000 MT by 1995 and between 4,000 MT and 7,000 MT by the year 2000.

. The industry in B.C. is at an experimental stage as it is experiencing severe duck predation, unexplained pre-harvest mortalities and other problems. Depending on the ability of the industry to deal with these problems on a cost efficient basis, the mussel industry in B.C. will either remain at an infancy stage and produce about 50 MT by the year 2000 or it will develop as a viable industry and potentially achieve a production of 1,000 MT.

TROUT FARMING INDUSTRY

. Trout production in Canada now exceeds about 2,500 MT with about two-thirds being produced from Ontario. Trout farming in Canada is primarily carried out in fresh water although the interest for marine culture has been growing, primarily in Nova Scotia. The industry is likely to produce between 2,800 MT and 5,200 MT of freshwater trout by 1995 and between 3,500 MT and 7,300 MT by the year 2000. Production of marine trout is likely to range between 1,000 MT and 4,000 MT by the year 2000.

COMBINED EMPLOYMENT IMPACTS

- In 1988, the salmon, oyster, mussel and trout farming sectors generated some 1,500 direct full time equivalent positions, excluding employment in hatcheries and industries supplying the industry. About 60% of this employment is in British Columbia, 28% is in Atlantic Canada , 10% is in Ontario and the remaining 2% is in Quebec and the rest of Canada.

- Employment in the salmon, oyster, mussel and trout farming sectors is expected to range between 1,875 and 3,230 full time equivalent positions by 1995 and between 2,165 and 5,030 by the year 2000.

- These employment projections represent the full time equivalent positions generated by the industry. The number of people involved in the industry, however, will likely be one to two times larger. The aquaculture industry involves seasonal employment and the culture of some of the species like mussels and trout is often done in combination with farming and other activities.

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Vancouver, B.C.
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APPENDICES

WORLDWIDE PRODUCTION OF FARMED SALMON, 1981-1988
(tonnes)

A. FARMED ATLANTIC SALMON

	1981	1982	1983	1984	1985	1986	1987*	1988*
Norway	8,910	10,266	17,016	22,300	28,655	45,675	47,000	80,000
Scotland	1,000	2,100	2,536	3,912	6,921	10,300	13,000	21,000
Ireland	35	103	257	385	650	650	2,000	5,000
Faroe Islands	100	130	160	300	450	600	2,500	3,600
Iceland	20	30	50	70	90	100	800	1,400
Sweden	60	80	100	75	150	150	150	150
Spain	0	0	0	0	150	150	150	150
Finland	0	0	0	0	0	40	50	50
Italy	0	0	0	0	0	50	50	50
Eastern Canada	28	48	126	163	188	297	600	2,800
Total	10,153	12,757	20,245	27,205	37,254	58,012	66,300	114,200

B. FARMED COHO AND CHINOOK

	1981	1982	1983	1984	1985	1986	1987*	1988*
B.C.	176	273	128	107	120	397	1,200	4,500
Chile	60	80	100	270	870	1,000	1,700	3,000
Western U.S.	450	680	900	1,176	1,257	1,507	2,025	2,500
Japan	1,150	2,122	2,760	5,049	6,430	7,220	12,000	15,000
France	60	80	80	90	100	180	200	200
New Zealand	2	5	10	20	500	500	1,200	1,600
Total	1,898	3,240	3,978	6,712	9,277	10,804	18,325	26,800

* Preliminary estimates

Source:

1988 production estimates are based on forecasts published in:

- Norway Fish Farming Abroad - A Special Edition of Norskfiskeoppdrett, September 1988.
- Worldwide Farmed Salmon Production Forecasts to the Year 2000. Study prepared for the Department of Fisheries and Oceans, Canada by the DPA Group Inc., March 1988.
- Atlantic Salmon Pen Strategies in Scotland, C.H. Aldridge, Sea Farm (Polly) Ltd., Inverness, Scotland, Aquaculture International Congress 1988, Vancouver, Canada, pages 405-406.

1987 Data: Worldwide Markets for Salmon, Pen Reared Salmon Impacts, prepared for the State of Alaska, April 1988.

1981-1986 Data: Worldwide Farmed Salmon Production Forecasts, report prepared for the Department of Fisheries and Oceans, Canada, by the DPA Group Inc., March 1988.

EXCHANGE RATES

	Norway	Chile	Scotland	U.S.
1975	0.1959	.1379*	2.2594	1.0173
1976	0.1809	.07412	1.7811	0.9861
1977	0.1998	.05158	1.8571	1.0635
1978	0.2178	.03653	2.1890	1.1402
1979	0.2314	.03172	2.4855	1.1715
1980	0.2378	.02995	2.7196	1.1690
1981	0.2094	.03074	2.4287	1.1990
1982	0.1923	.02608	2.1579	1.2341
1983	0.1690	.01556	1.8683	1.2324
1984	0.1599	.01339	1.7300	1.2948
1985	0.1596	.008663	1.7701	1.3652
1986	0.1881	.007388	2.0388	1.3894
1987	0.1970	.006154	2.1725	1.3260
1988 (October)	0.1790	.004890	2.1581	1.2227

Note: * Commercial rate for 63 days. Currency fluctuated widely during that year.

Source: Bank of Canada